Prince Edward Island Canada Agriculture and Forestry

# Prince Edward Island Soil Quality Monitoring – 2012

## Soil nutrient status over the last 15 years in Prince Edward Island

## INTRODUCTION

Agriculture is one of the most important industries in Prince Edward Island (PEI). Based on 2012 Statistics Canada data the population of PEI living in rural areas is 1.5% higher than the national average. Potatoes covered an area of 86,560 acres in 2011 (Statistics Canada, 2012) representing the most important crop in terms of farm cash receipts. The distribution of crop types is dynamic and has changed over the last number of years according to the 2011 census of agriculture. Since 2006, grain corn increased 151.3%, canola area increased from 158 acres in 2006 acres to 2,962 acres in 2011, cranberry acreage increased 46%, and soybean increased by 351%. The change in land use implies variations in soil nutrients and the importance of assessing long-term trends for a better soil nutrient management.

## METHODS

The PEI Department of Agriculture has conducted a long-term soil quality monitoring project in 1998 (Douglas et al.2000) with the objective to monitor crop nutrient status across the province. One third of the province was GPS sampled every year in such a way to cover the total agricultural land every three years for a total of 796 sampling points. The first third of the samples were taken in the spring of 1998, the second in the spring of 1999 and the last third during the spring of 2000. In other words, geo-referenced samples were taken at each site once every three years from 1998 to 2011.

Samples were taken in the spring after the frost was out of the ground and before spring tillage or crop was seeded. At each site, cropping history was monitored from 1998 to 2011 and the information was used to assess crop frequency at each site. Assuming that contrasting crops affect differently nutrient dynamics over time, five crop group variables were created: forage, grains, potatoes, soybean, corn and others. Forages included hay, pasture, and grass and “others group” included vegetables, blueberries, turnips, canola, tobacco, beans, ditch, buffer zone, cabbage, etc. Statistical analysis was performed using SAS (SAS institute, 2010) to evaluate the effect of year, crop frequency on soil organic matter, phosphorus, potassium, magnesium, calcium and pH. Effects on trace elements were also evaluated but only results related to macro elements are reported here.

## RESULTS

### Effect of time and crop frequency on organic carbon, phosphate, potassium, magnesium, calcium and on pH

To better analyse the trend of nutrients over time, sites that were sampled in the same time were grouped together (Figs 1,3,4, 5, 6). For all analyzed parameters, time effect was statistically significant.

Averaged across all sampled sites, organic matter decreased overtime (Fig. 2). The diminution was more pronounced with increased frequency of potatoes (Fig. 8), grain (Fig.10) and soybean (Fig. 12) than forage (Fig.9).The main crop rotation system in PEI is potatoes - barley under seeded with red clover. Straw barley is generally exported and the amount of residues returned to the soil during red clover phase is not sufficient to build up the organic matter in the long term as was demonstrated here. Conversely, organic matter seems to be stable under corn production (Fig. 11) probably due to the fact that grain corn leaves a large amount of crop residues but also because corn is mainly grown on dairy farms where manure is applied at a regular basis. Previous studies conducted on long-term studies showed that applying manure regularly even at low amount helped to build up organic matter and to sustain yields under low-residue cropping systems (Nyiraneza et al., 2010). This study showed that the organic matter in PEI will continue to decrease over time under the current rotation systems.

Contrary to the organic matter, the study showed that average values of phosphorus showed increasing trends over time (Fig. 3) and increased with frequencies of potatoes (Fig.23) and grain production (Fig. 25) as P fertilizer is applied under these crops. Including forage crop helps to decrease phosphate levels as P fertilizer is not generally applied under this crop (Fig.24). Continued inputs of P fertilizer in excess of crop requirements can lead to a build-up of soils levels and thus increase the potential of P transports. Several methods have been suggested to estimate P saturation using ammonium oxalate and Mehlich-3 extractants. Critical soil P saturation indices were established over which there is a great soil P solubility and risk for P movement. The Mehlich-3 extractant has been suggested as an agri-environmental soil test by Khiari et al.(2000) on coarse soils in Quebec. Mehlich 3 extractant is used in the PEI soil testing lab and is convenient as soluble P and Aluminium and iron can be extracted simultaneously. From Khiari et al. (200) and Sims et al. (2002) studies, the critical value is situated around 10% when P/(Al+Fe) ratio is used and 15% in case of P/Al ratio. From fig. 28 to 32, it is evident some of sampled sites have values of P/(Al+Fe) above the critical value of 10% and when averaged across all sites, the same ratio is oscillating around critical value except in 2003 where P/(Al+Fe) ratio was around 15% (Fig. 2). Greater soil P solubility and a risk for P movement may occur in those soils where P/(Al+Fe) is greater than 10 and additional studies are needed to assess P fixation capacity of these soils. Phosphorus saturation index according to the frequency of different crops followed the same trend as phosphate levels showing increasing levels as the potato and grain frequencies increase (Fig. 28 to 32).

Mixed results were obtained regarding potassium with positive trends in two thirds of sampled site and negative trend in sites sampled starting in 2000 (Fig. 4) and under soybean (Fig. 22). Trends toward slight increases were observed with high frequency of potatoes (Fig.18) but potassium seems to be stable under forages (Fig.19), grain (Fig.20) and corn (Fig.21).

Similarly to potassium, mixed results were observed with calcium (Fig. 5; Figs.38-342) and pH (Fig.7; Figs. 13-17). In general, pH tends to decrease as potato (Fig. 13), forage (Fig.14) and soybean (Fig.17) frequencies increase. Contrasting results of calcium and pH at sampled sites may be explained by differences in lime application time with respect to sampling time.

Average values of magnesium are decreasing over time (Fig. 6) and when potato (Fig.33), soybean (Fig.36), and grain (Fig.35) frequencies increase. Build-up of Mg were observed under corn (Fig. 37) due to reasons cited above linked to the fact that most of corns is under manured fields. Dolomitic limestone is often applied under forage phase which might the positive trend observed (Fig.34). These results are evidencing that crop Mg requirements need to be fine-tuned to avoid crop deficiency in this element. Plants are deficit to Mg in the soil having low pH, sandy in nature and highly leached soil with low Cation Exchange Capacity (Tisdale *et al.*, 1990). Magnesium deficiencies are most frequently found in the region of heavy rainfall and in light textured soils. Magnesium is an important constituent of chlorophyll molecule, therefore, essential for photosynthesis. Magnesium increases NPK uptake and thus enhances yield and promotes uptake and translocation of phosphorus.

**CONCLUSIONS**

Maintaining adequate soil organic matter in a soil is the foundation of sustainable production systems. Soil organic matter depends largely to the quality and quantity of organic matter inputs (residues and roots) and litter decomposition. Results from this long-term study showed that current rotations systems are not sufficient to stop SOM decreasing in PEI unless animal manure or other carbon-rich wastes are regularly applied to the soil.

Further studies are needed to evaluate optimum rate of phosphorus and Mg to boost crop production in PEI to avoid crop Mg deficiencies and soil P saturation. Increasing P accumulation observed under potato and grain productions may translate a risk to a partial or complete P sorption sites saturation that can lead to an increase in P leaching or P transported into surface waters. Agronomic and environmental P threshold values need to be determined for main crops of PEI to validate crop P recommendation.

**ACKNOWLEDGEMENT**

The PEI Department of Agriculture and Forestry would like to thank Dr. Judith Nyiraneza, Research Scientist, Nutrient management specialist, Agriculture and Agri-Food Canada and her colleagues for their analysis, interpretation, compilation and report preparation of the Provincial Soil Quality Monitoring database.

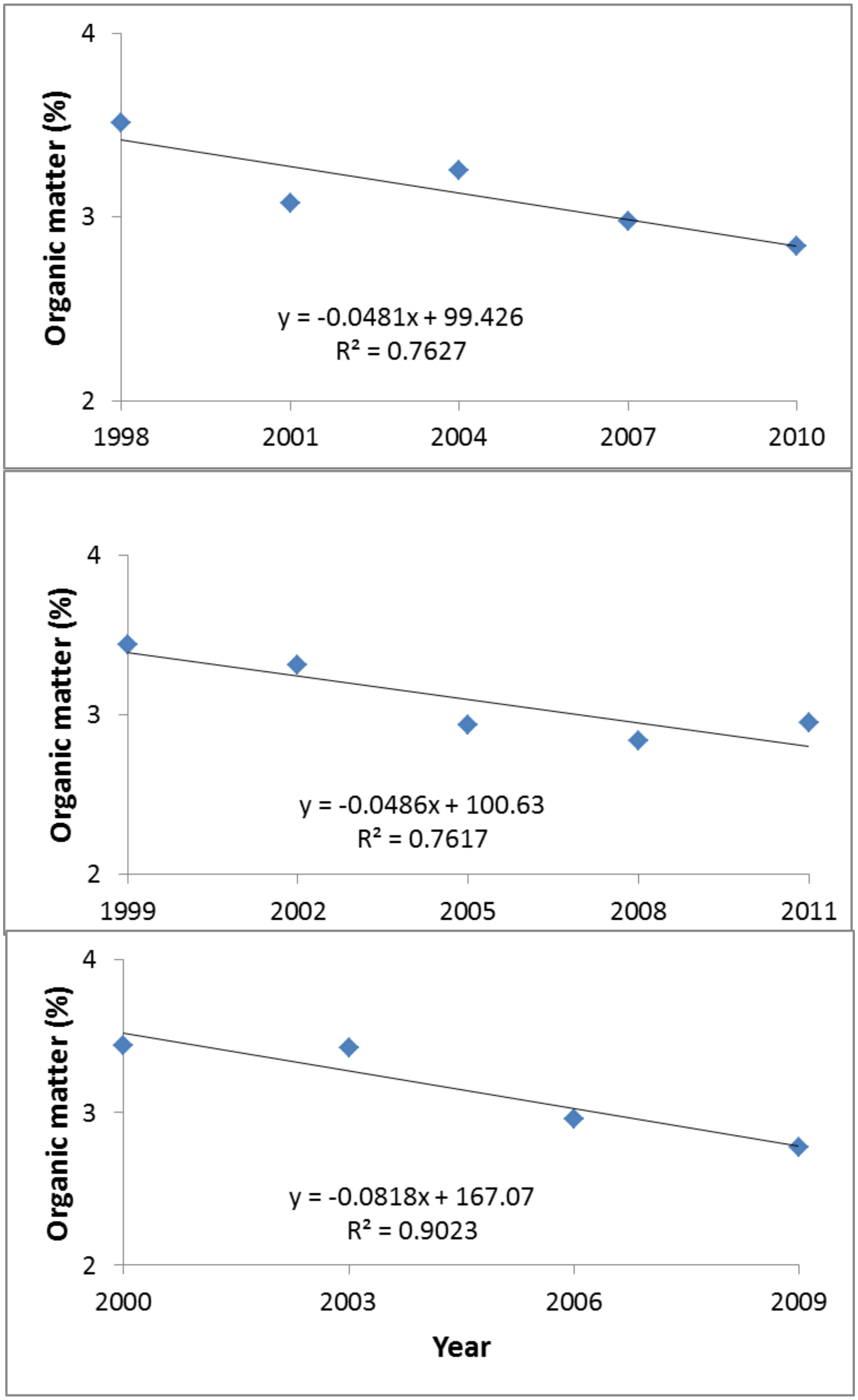


**Figure 1. Effect of time on organic matter**

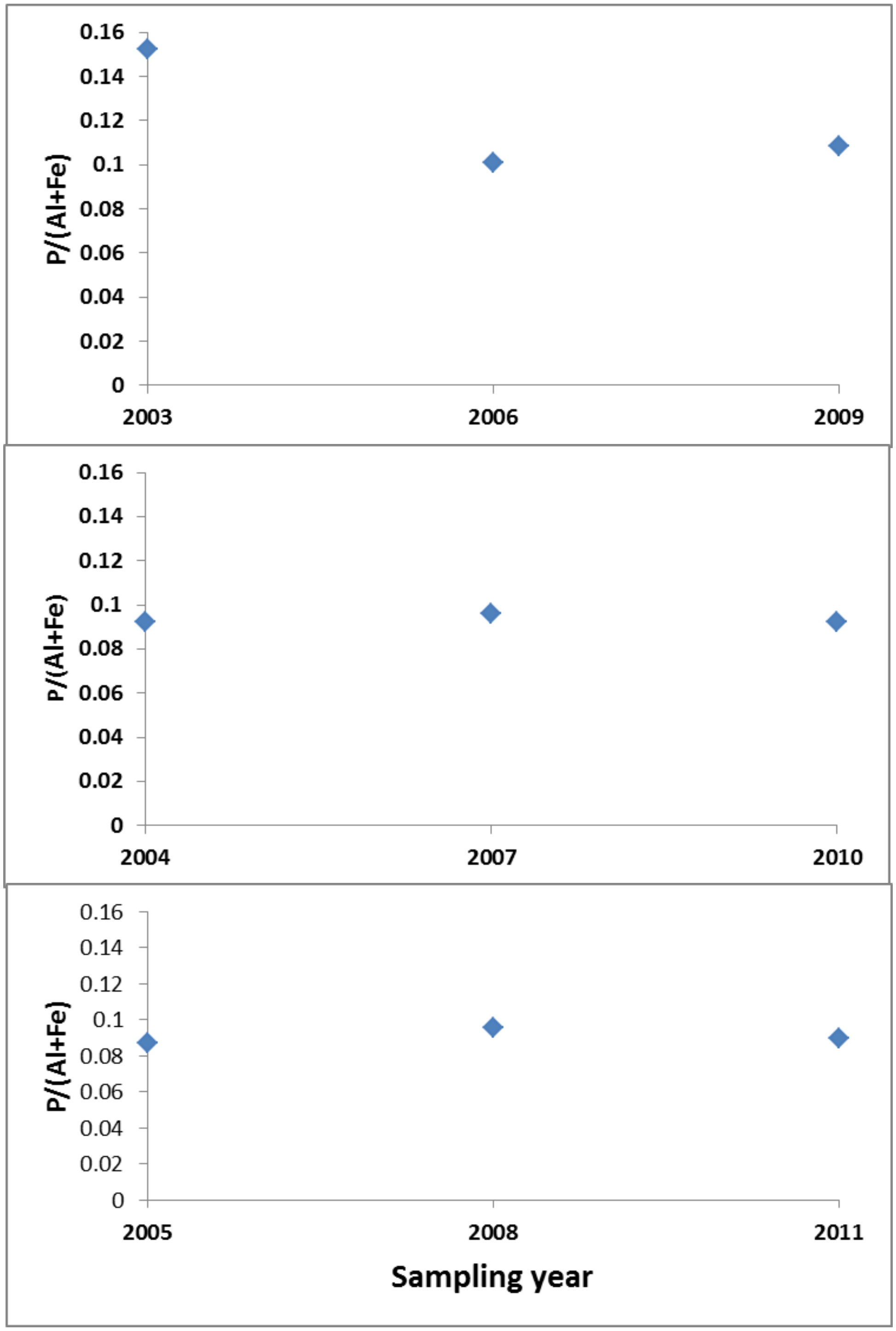


**Figure 2. Phosphorus saturation index (P/(Al+Fe) ratio averaged across sites per sampling year using Mehlich-3 extractant**

**No time trend is shown because we have only few observations due to the fact that aluminium content was measured since 2003.**

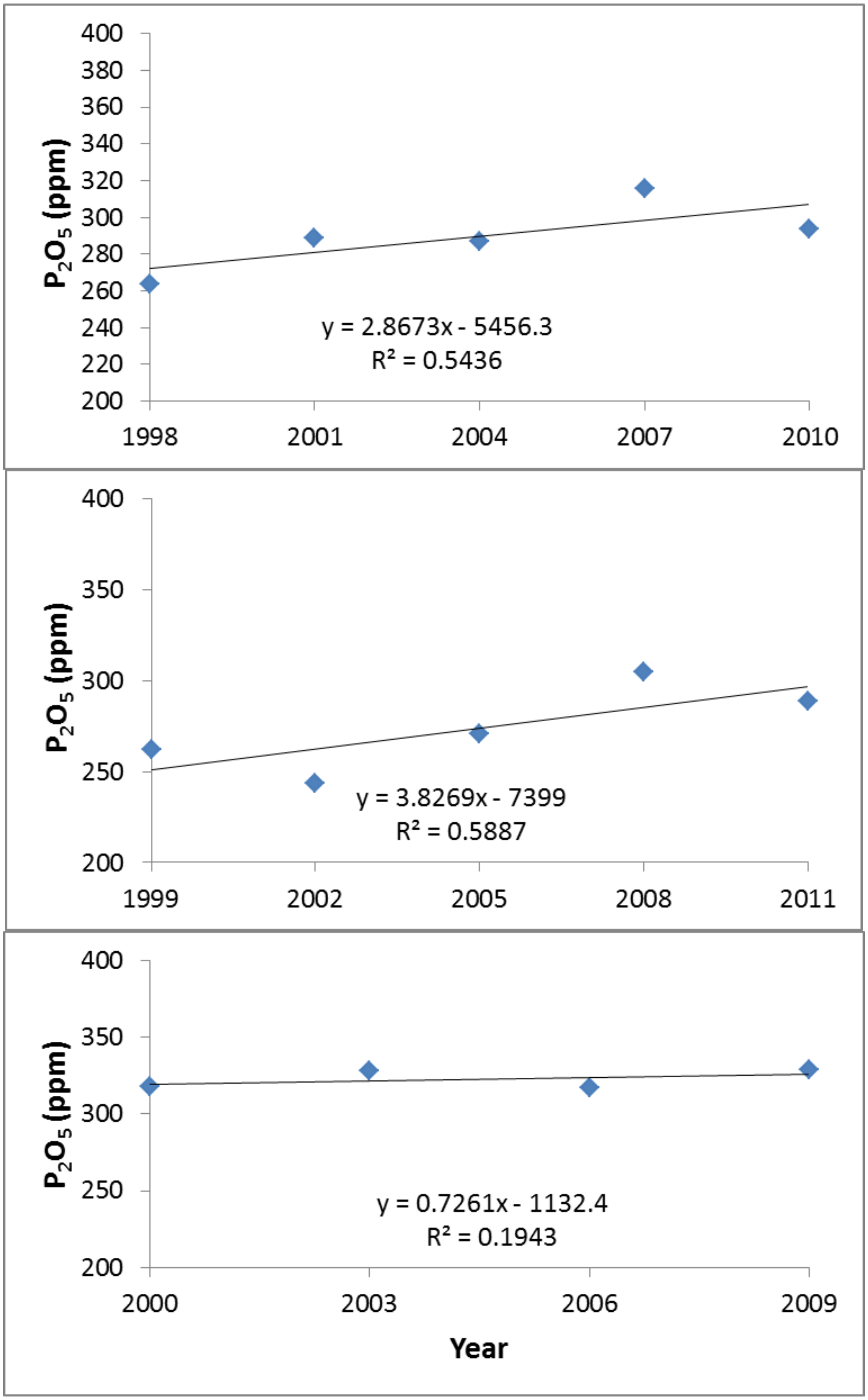


**Figure 3. Effect of time on phosphate ($P_2O_5$)**

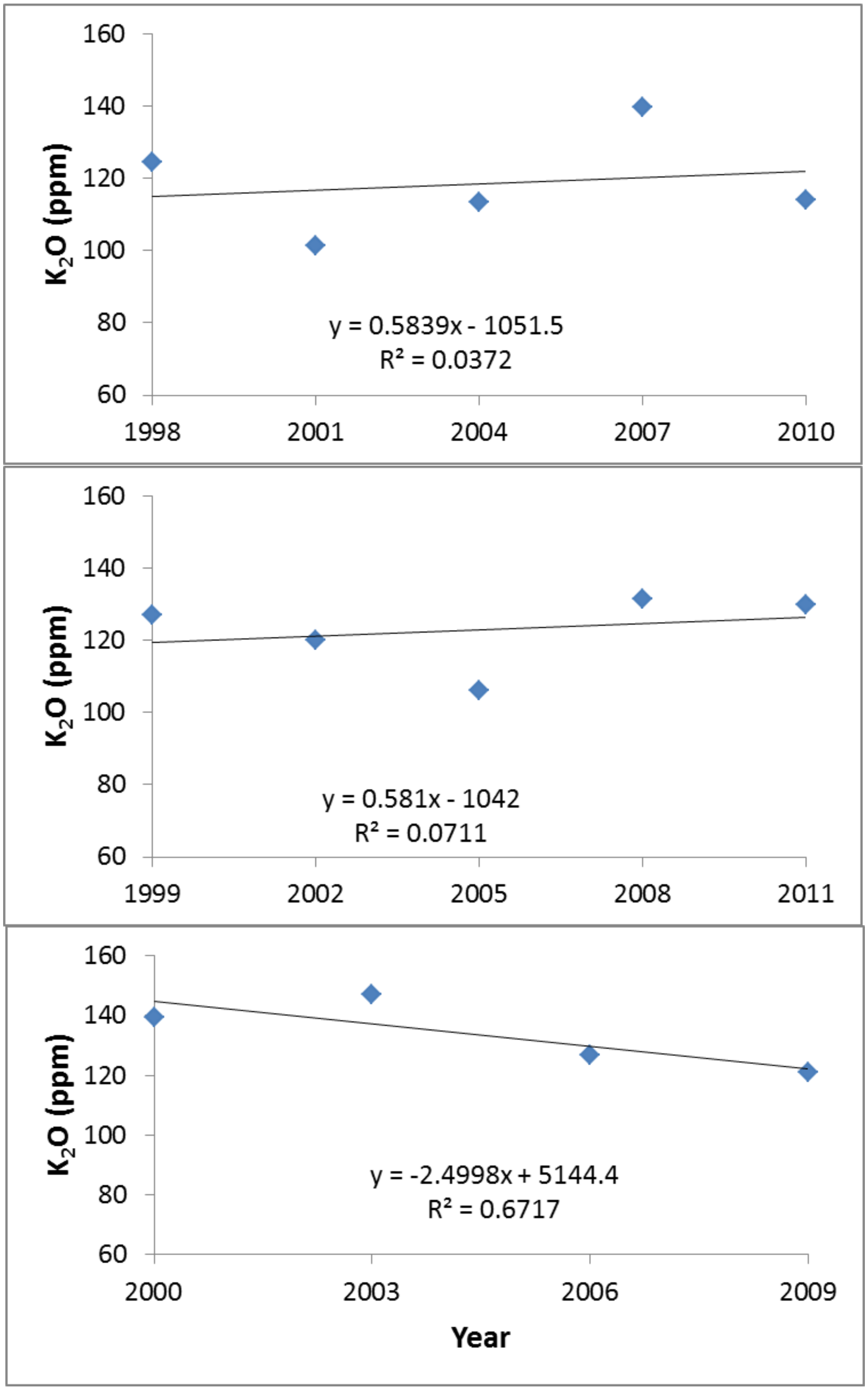


**Figure 4. Effect of time on potassium ($K_2O$)**

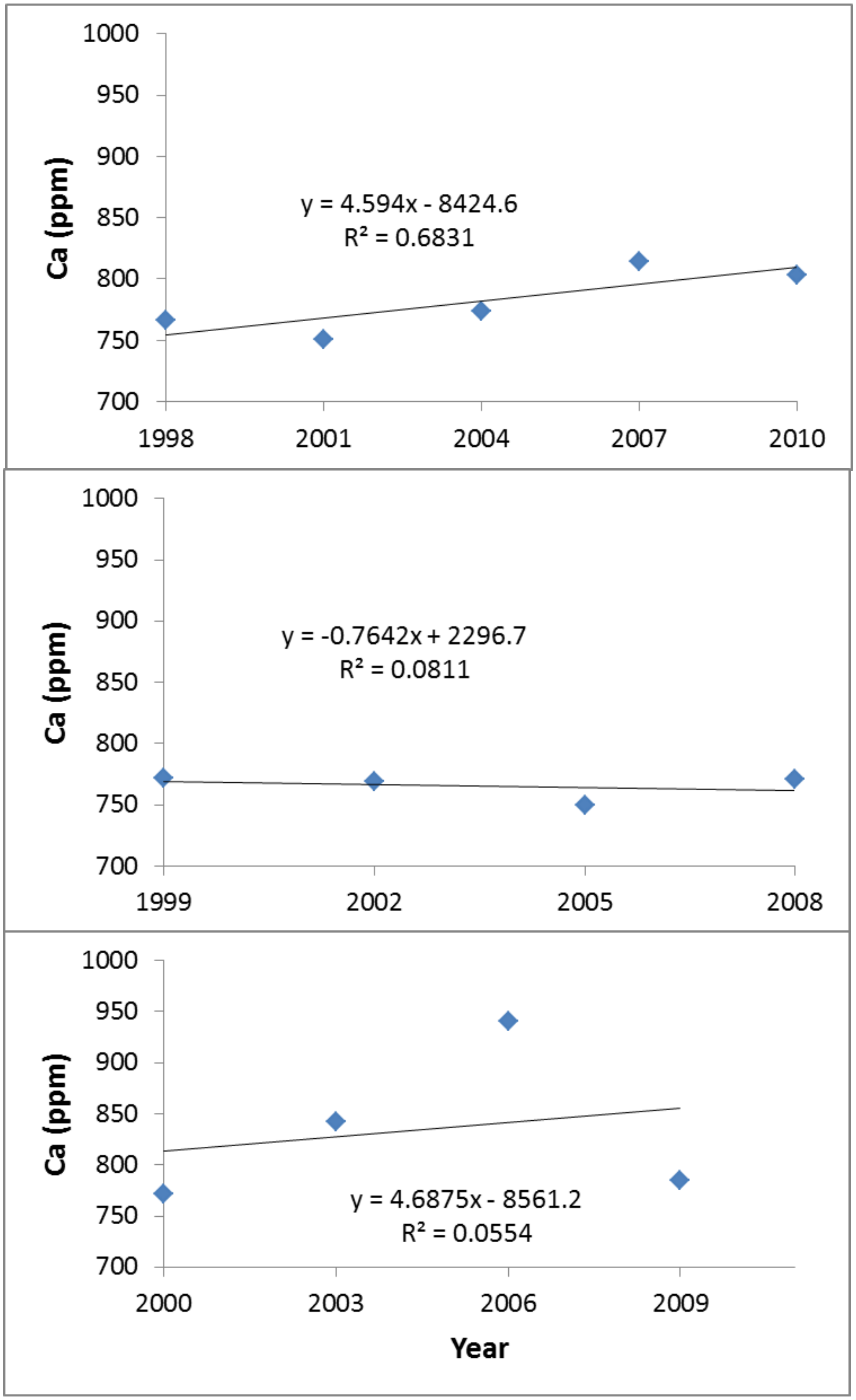


**Figure 5. Effect of time on calcium (Ca)**

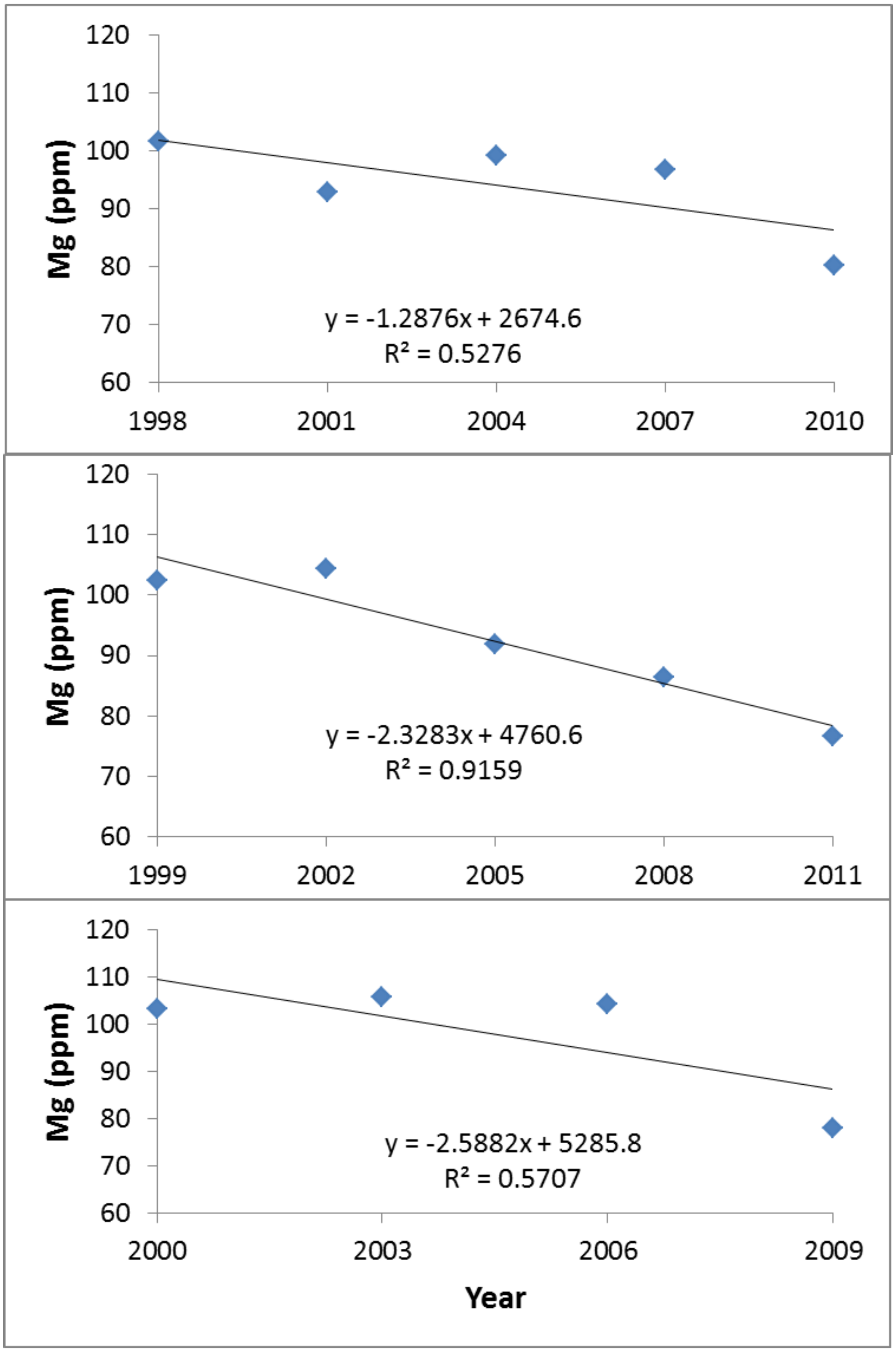


**Figure 6. Effect of time on magnesium (Mg)**

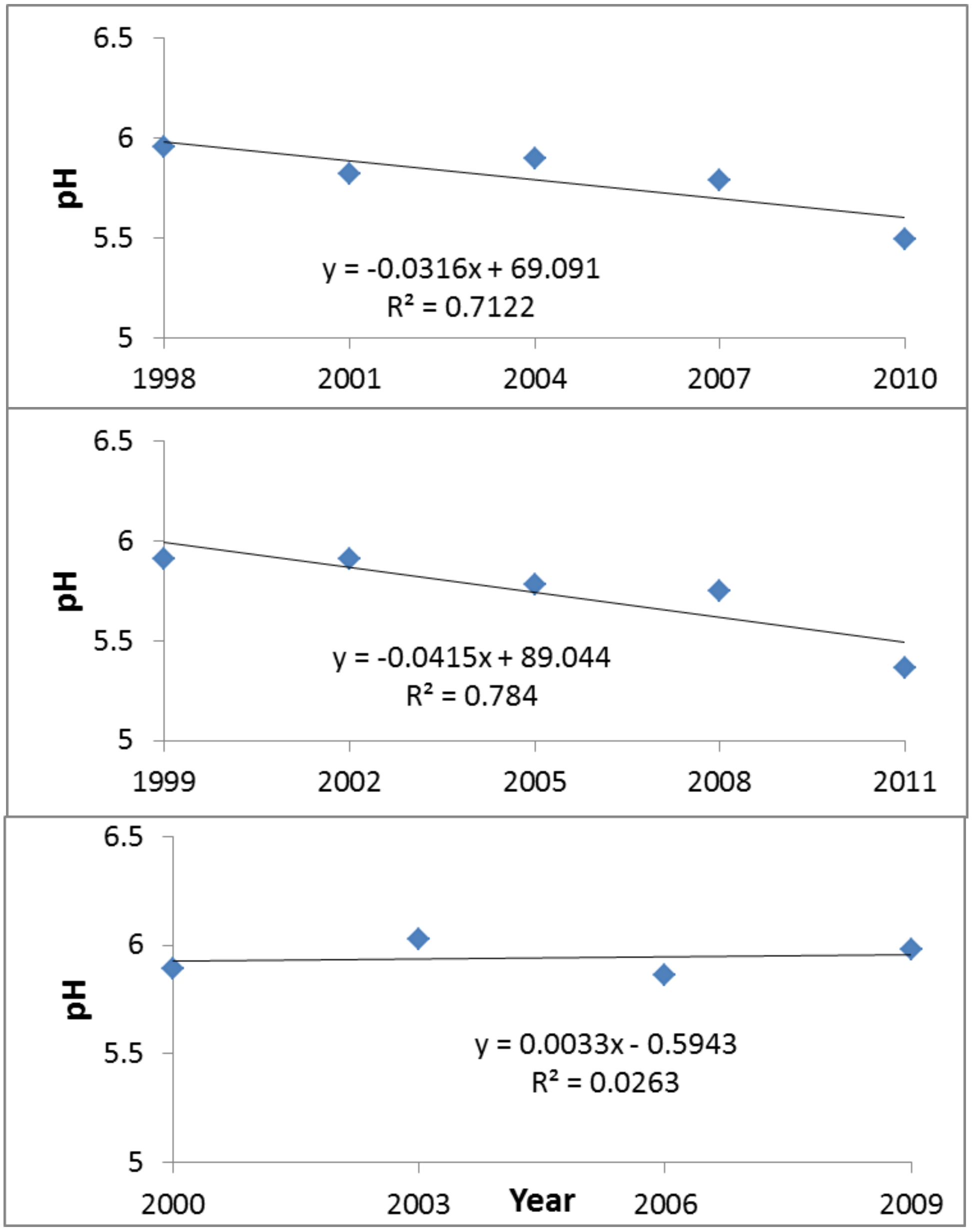


**Figure 7. Effect of time on pH**

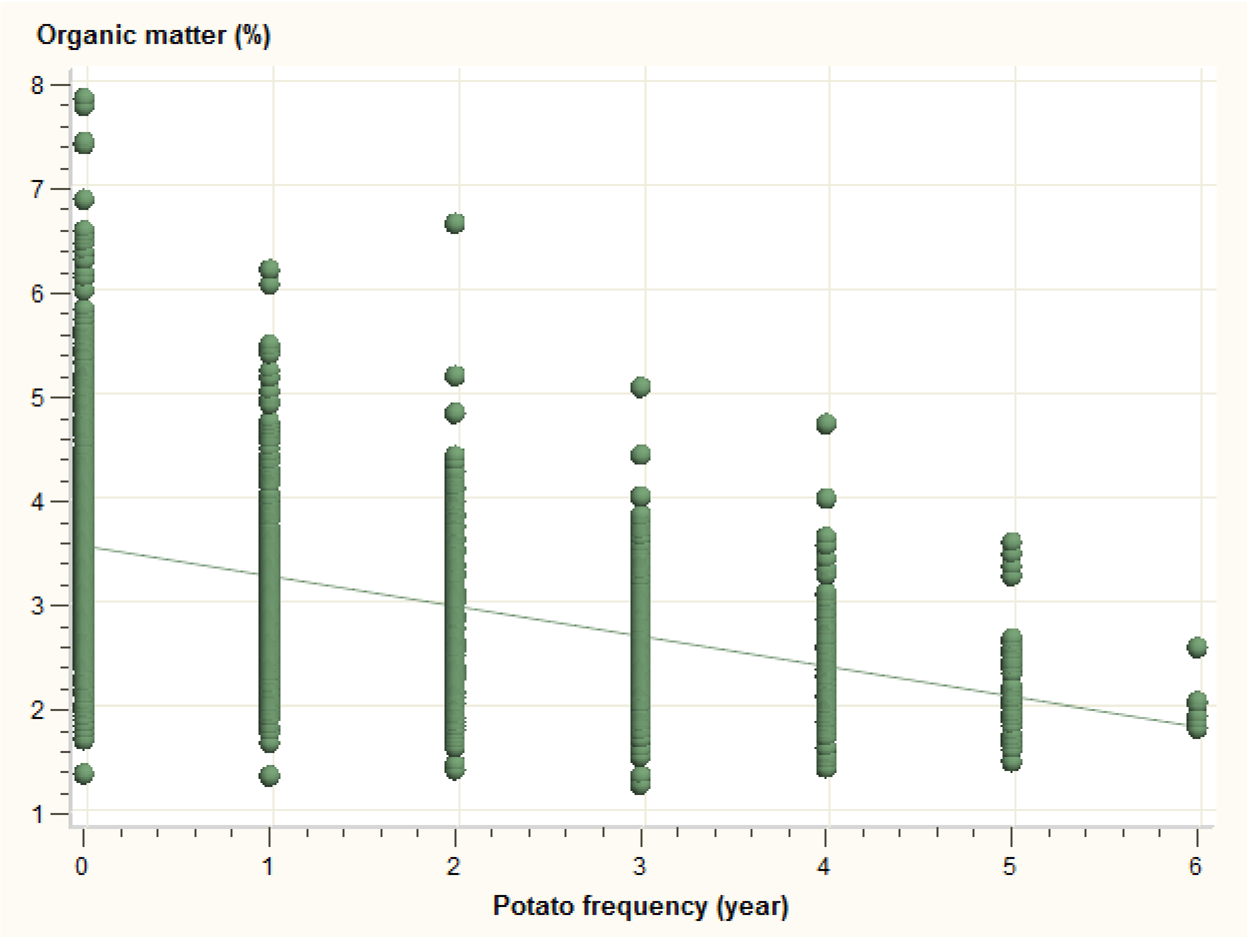


**Figure 8. Organic matter trend versus potato frequency at sampled sites**

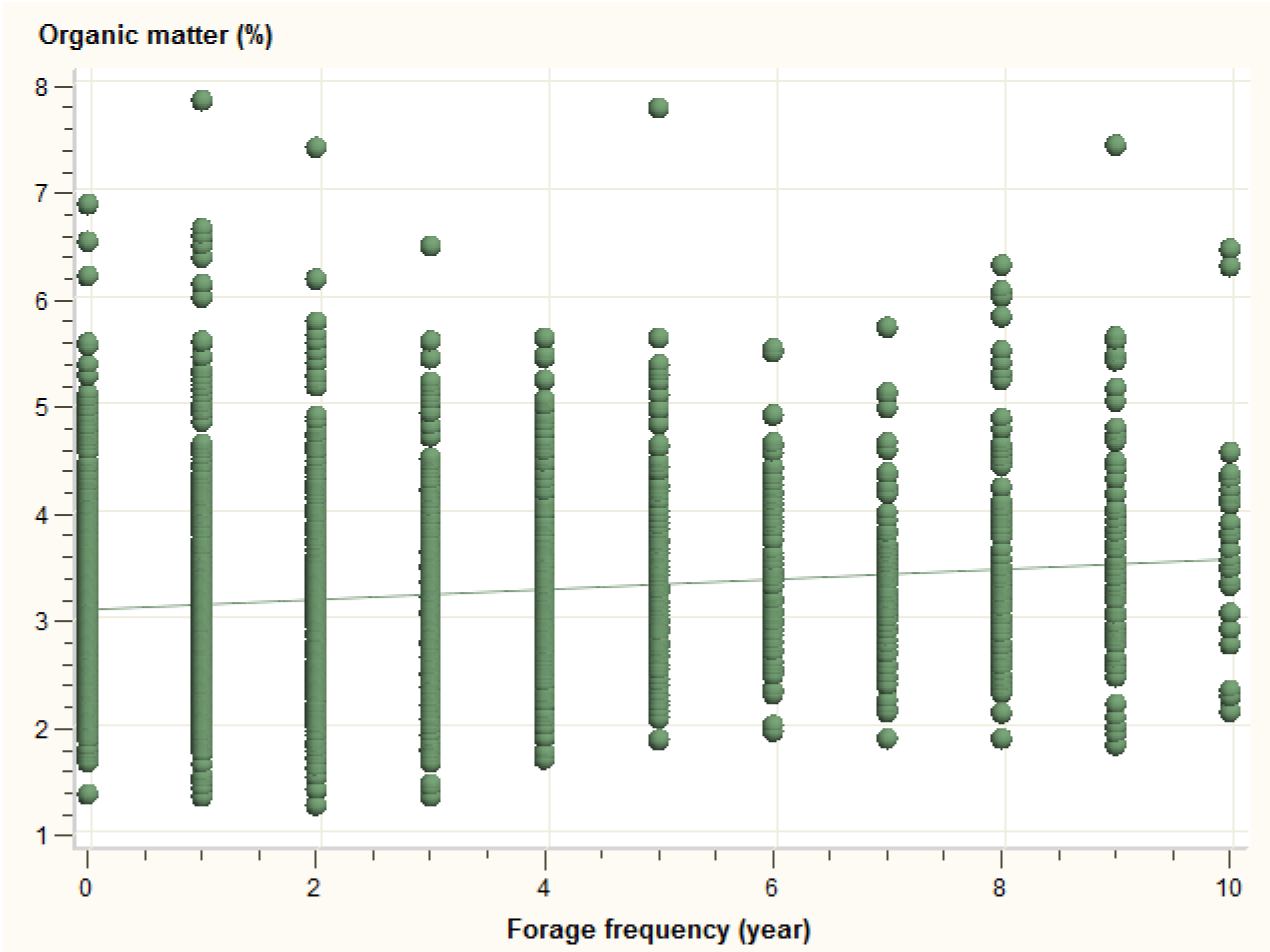


**Figure 9. Organic matter trend versus forage frequency at sampled sites**

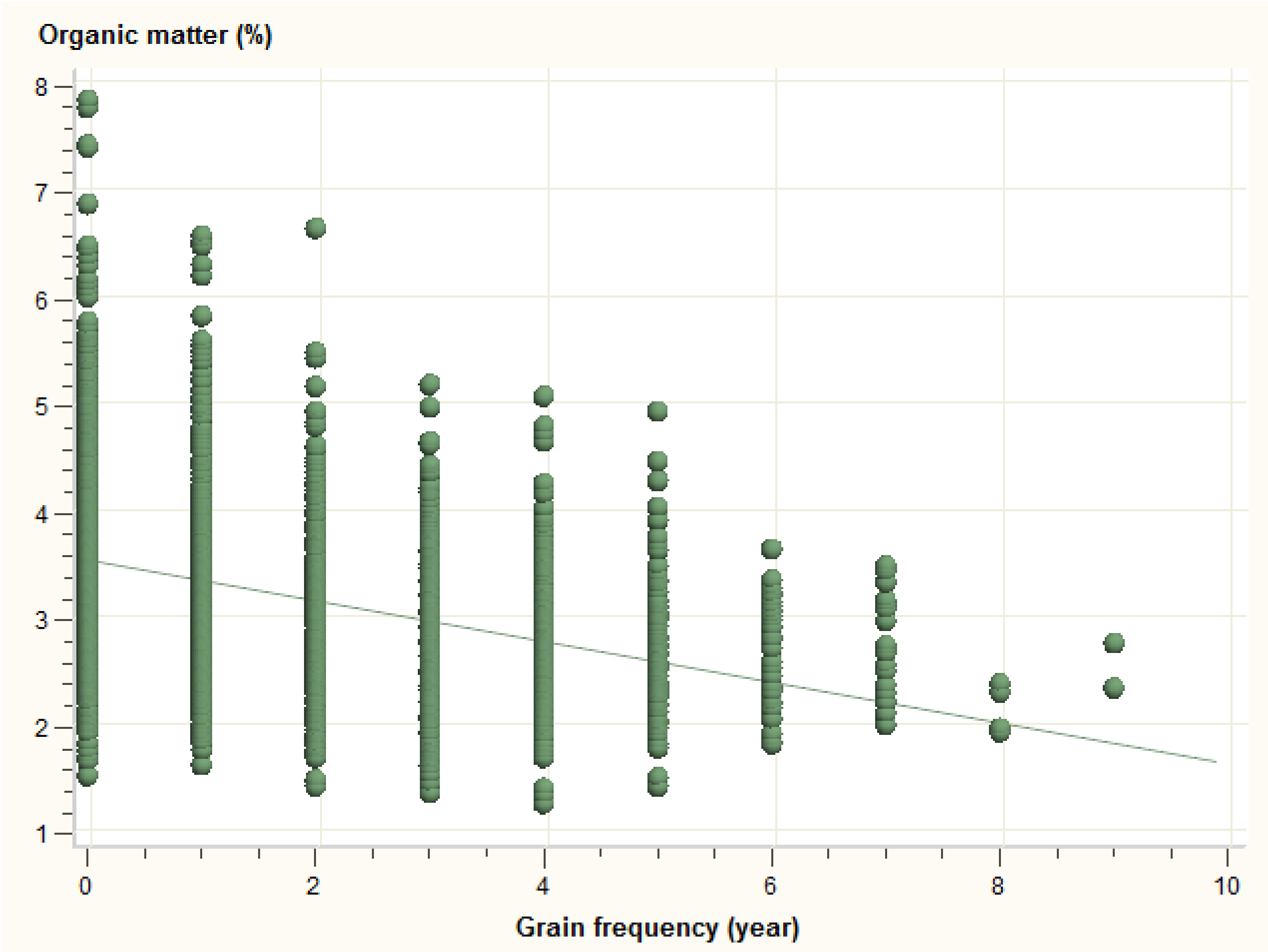


**Figure 10. Organic matter trend versus grain frequency at sampled sites**

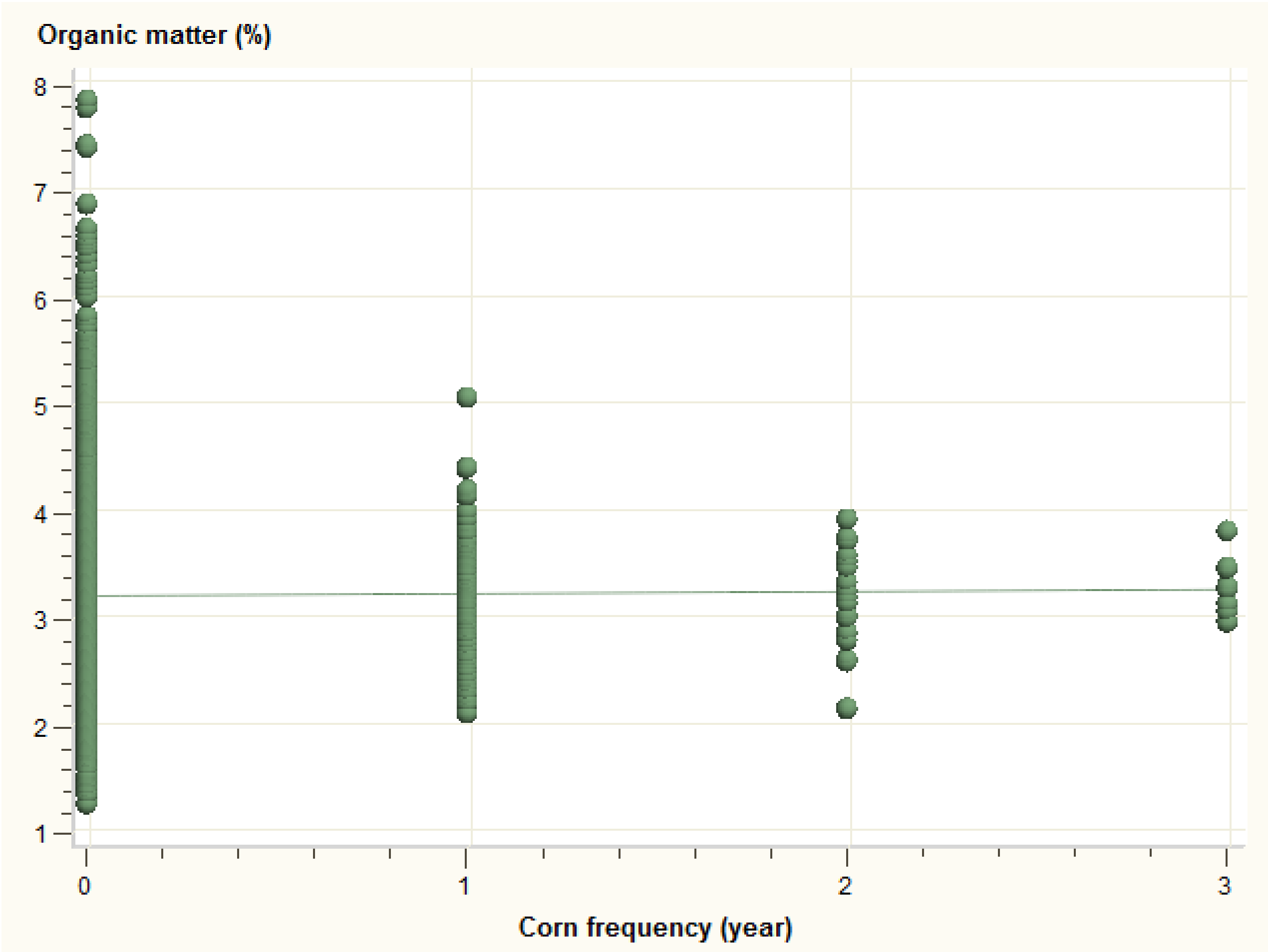


**Figure 11. Organic matter versus corn frequency at sampled sites**

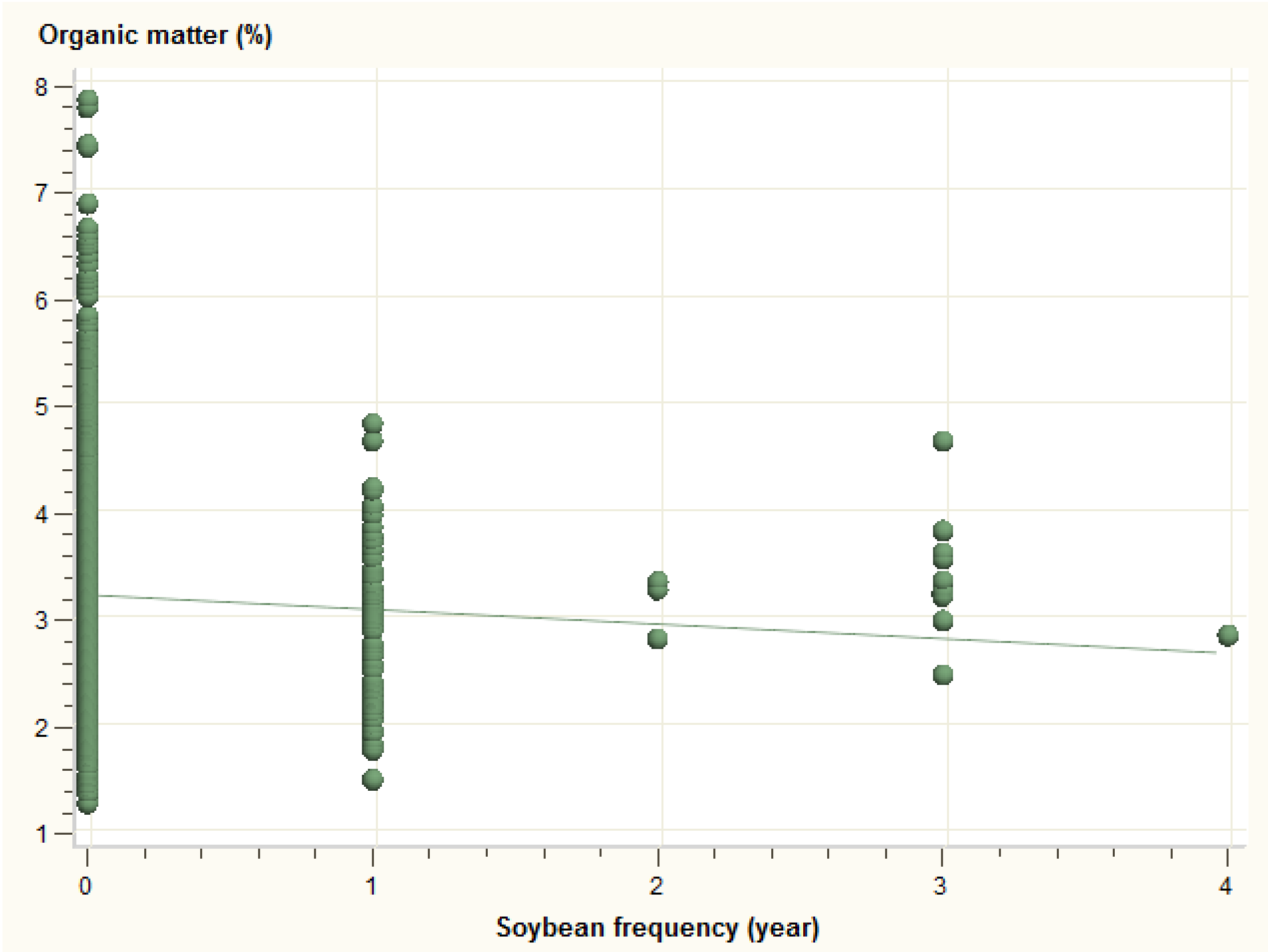


**Figure 12. Organic matter trend versus soybean frequency at sampled sites**

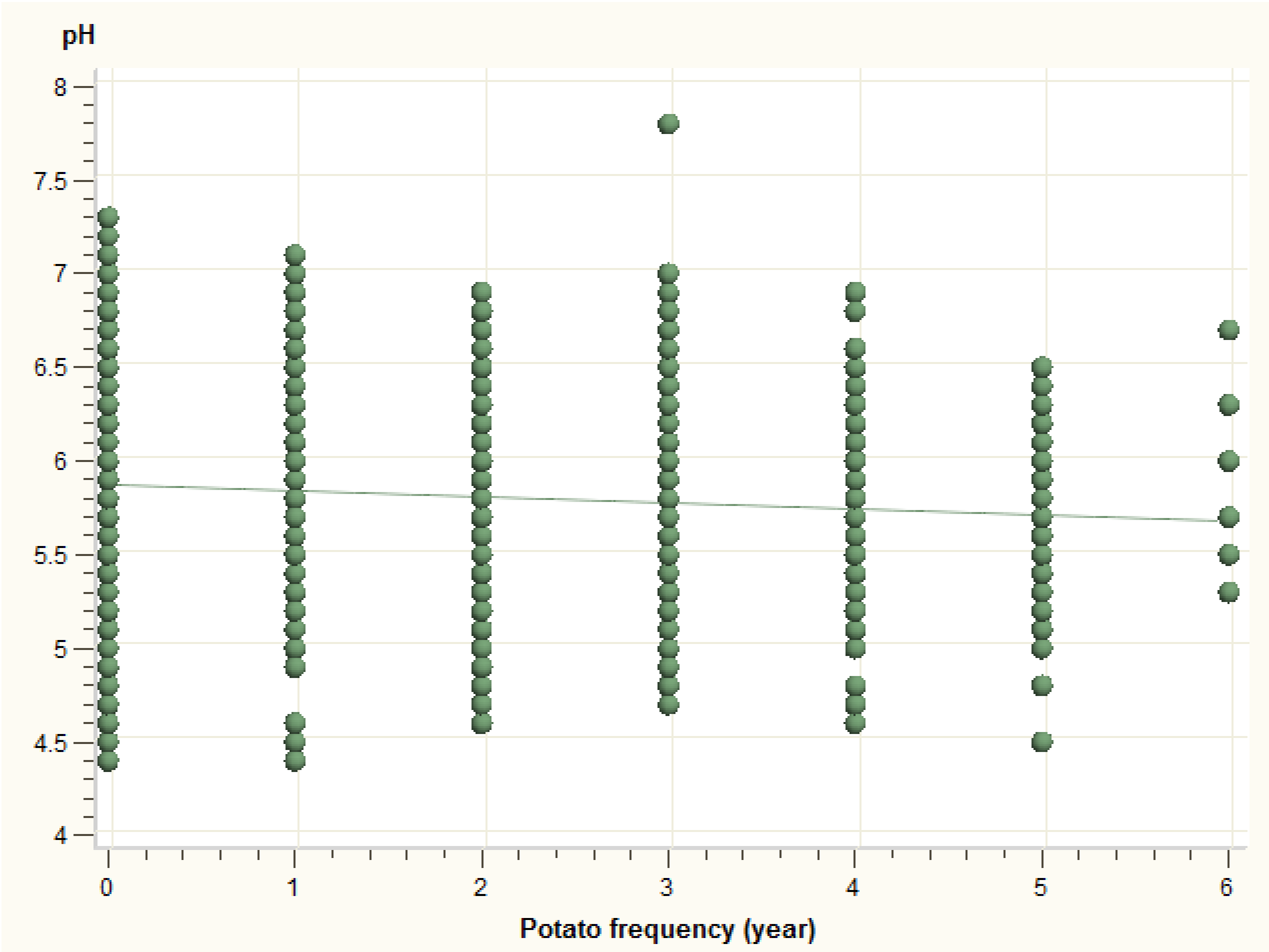


**Figure 13. pH trend versus potato  frequency at sampled sites**

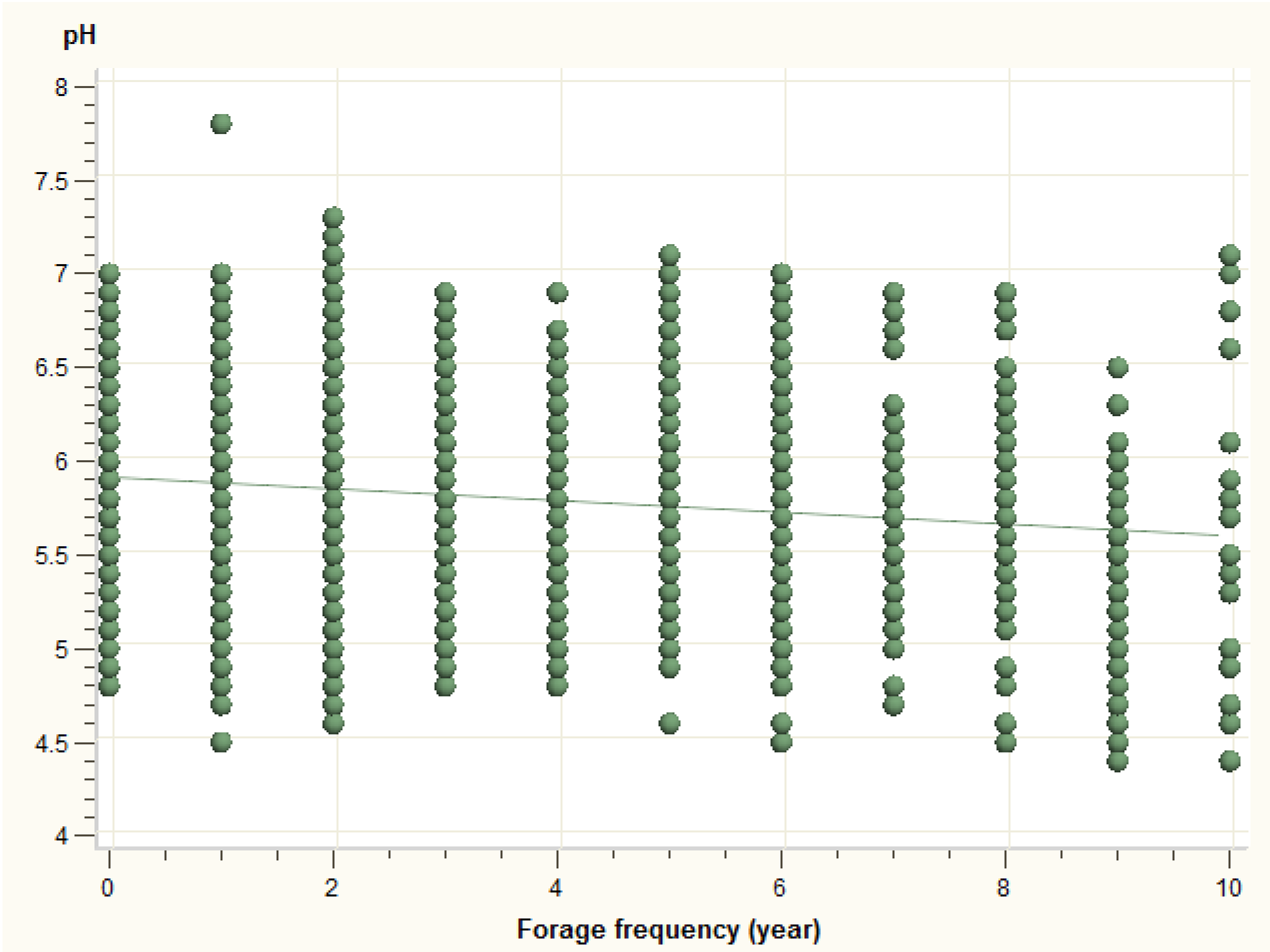


**Figure 14. pH trend versus forage frequency at sampled sites**

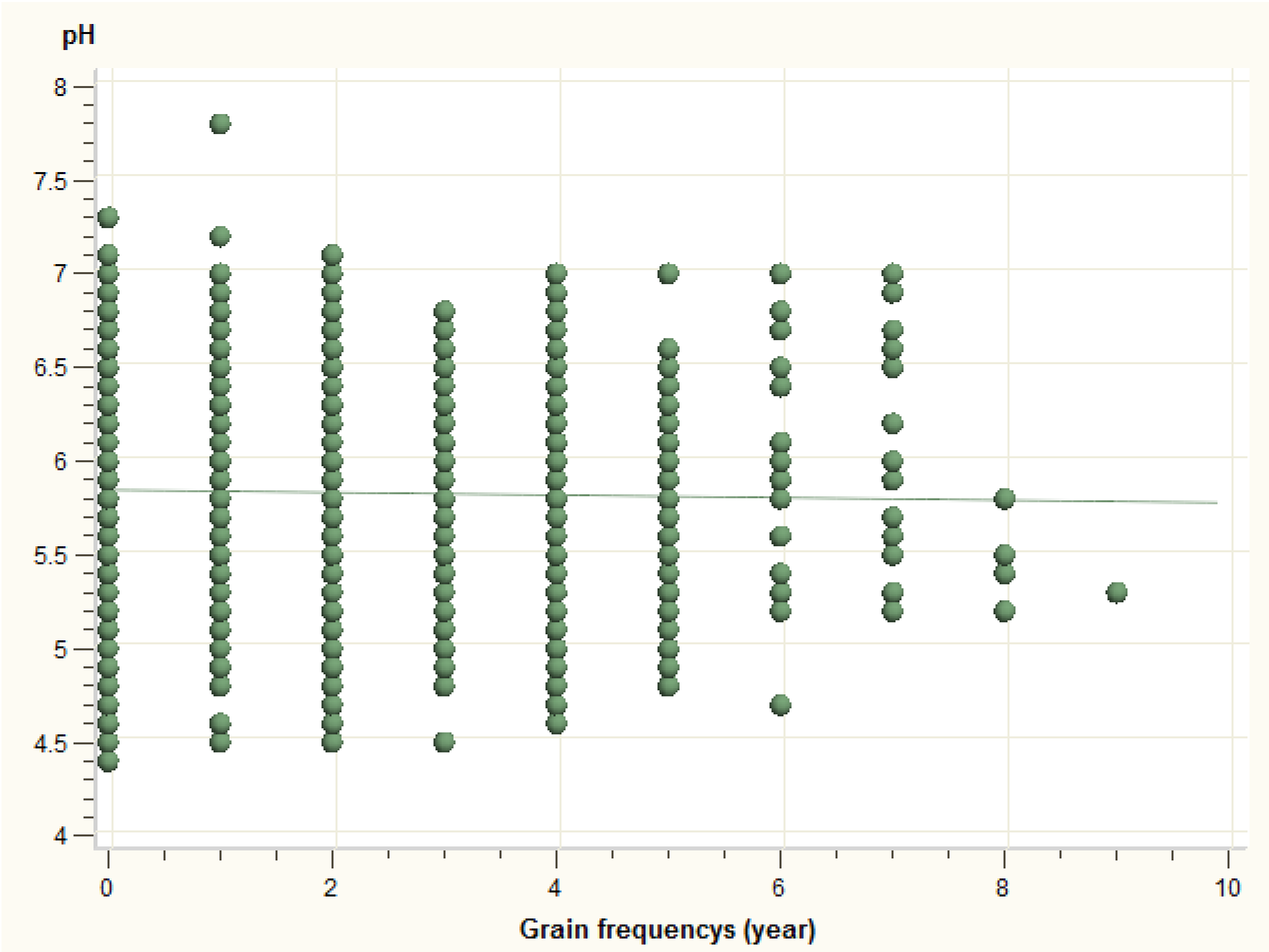


**Figure 15. pH trend versus grain frequency at sampled sites**

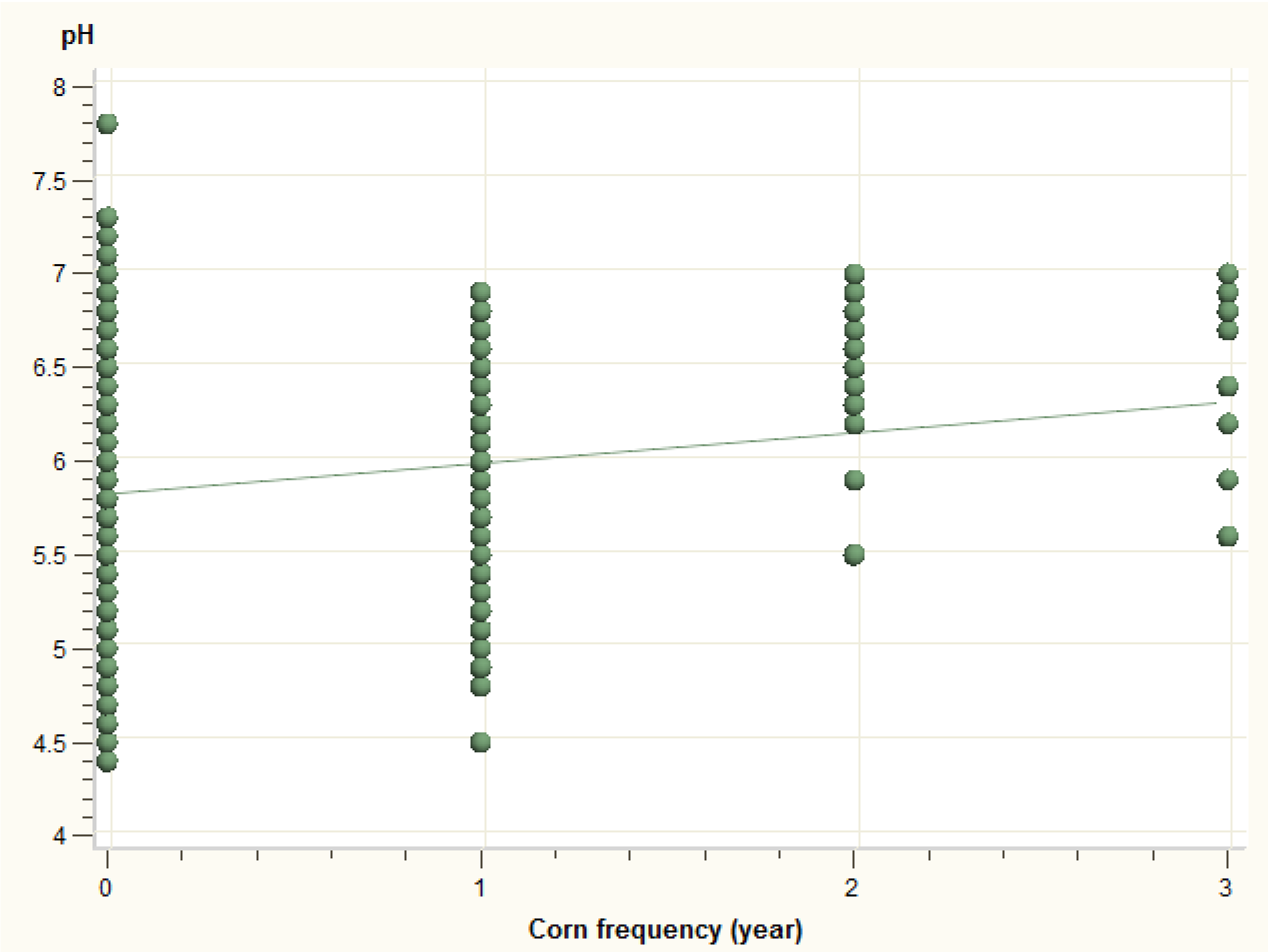


**Figure 16. pH trend versus corn frequency at sampled sites**

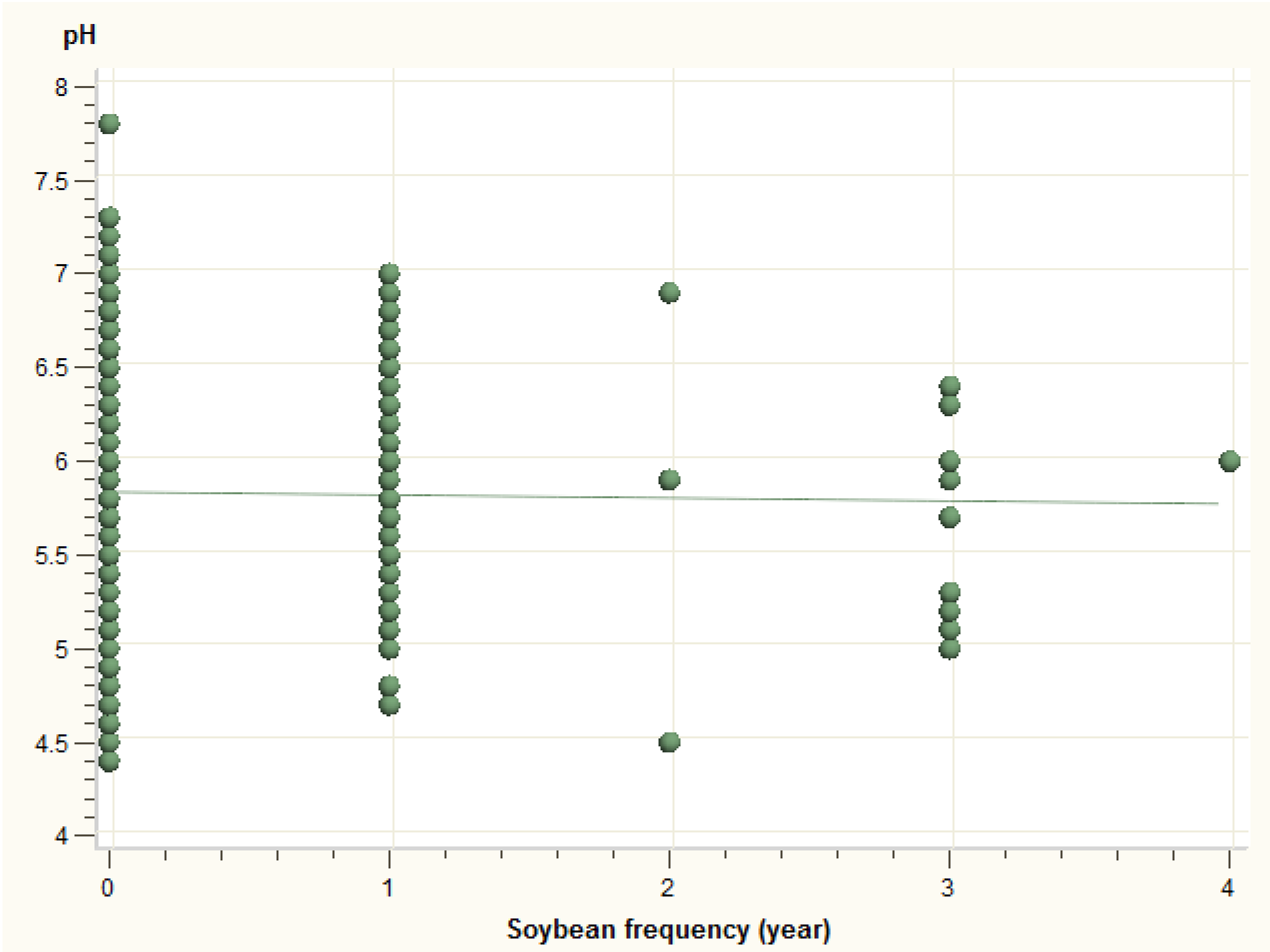


**Figure 17. pH trend versus soybean frequency at sampled sites**

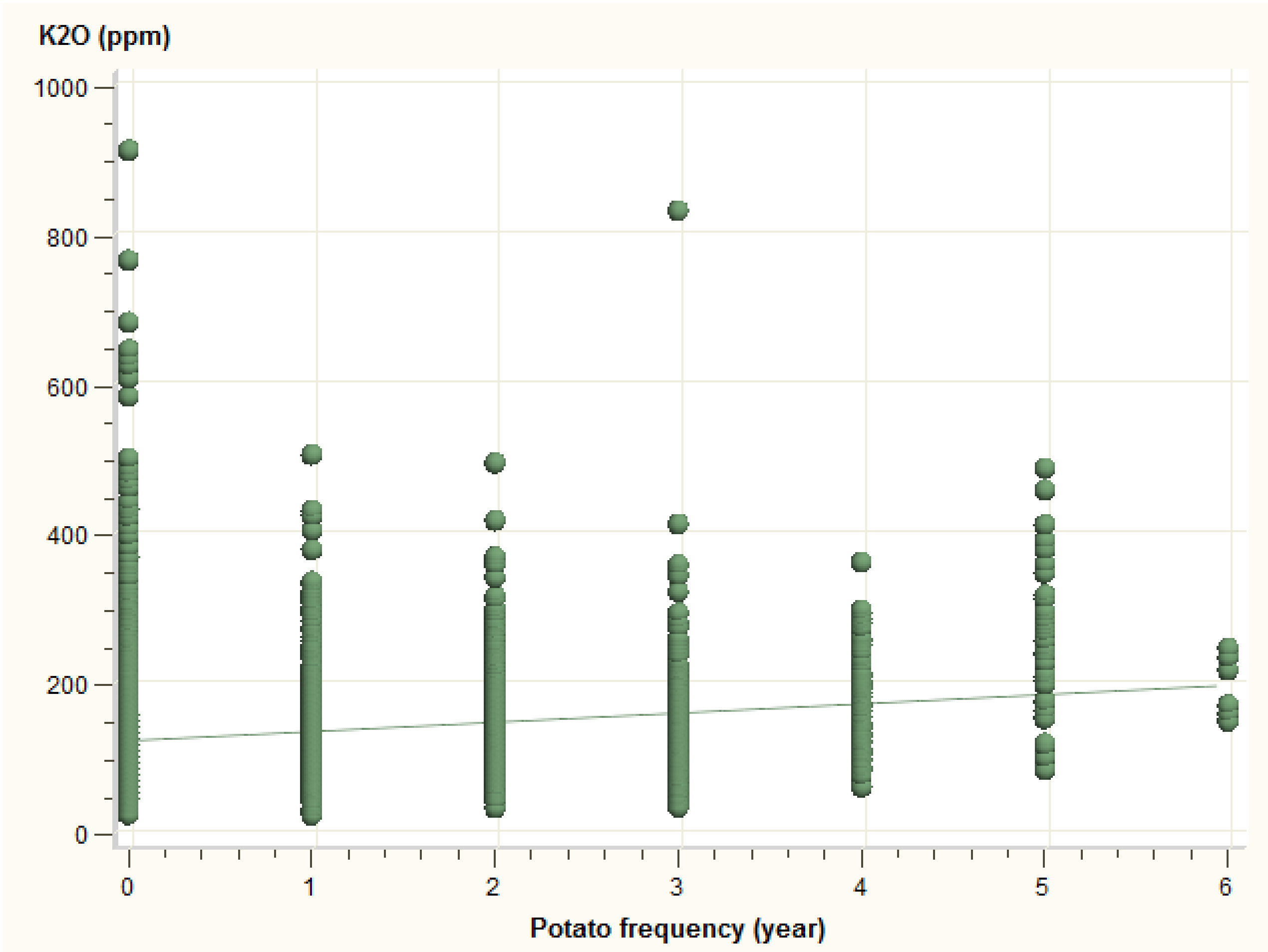


**Figure 18. Potassium trend versus potato frequency at sampled sites**

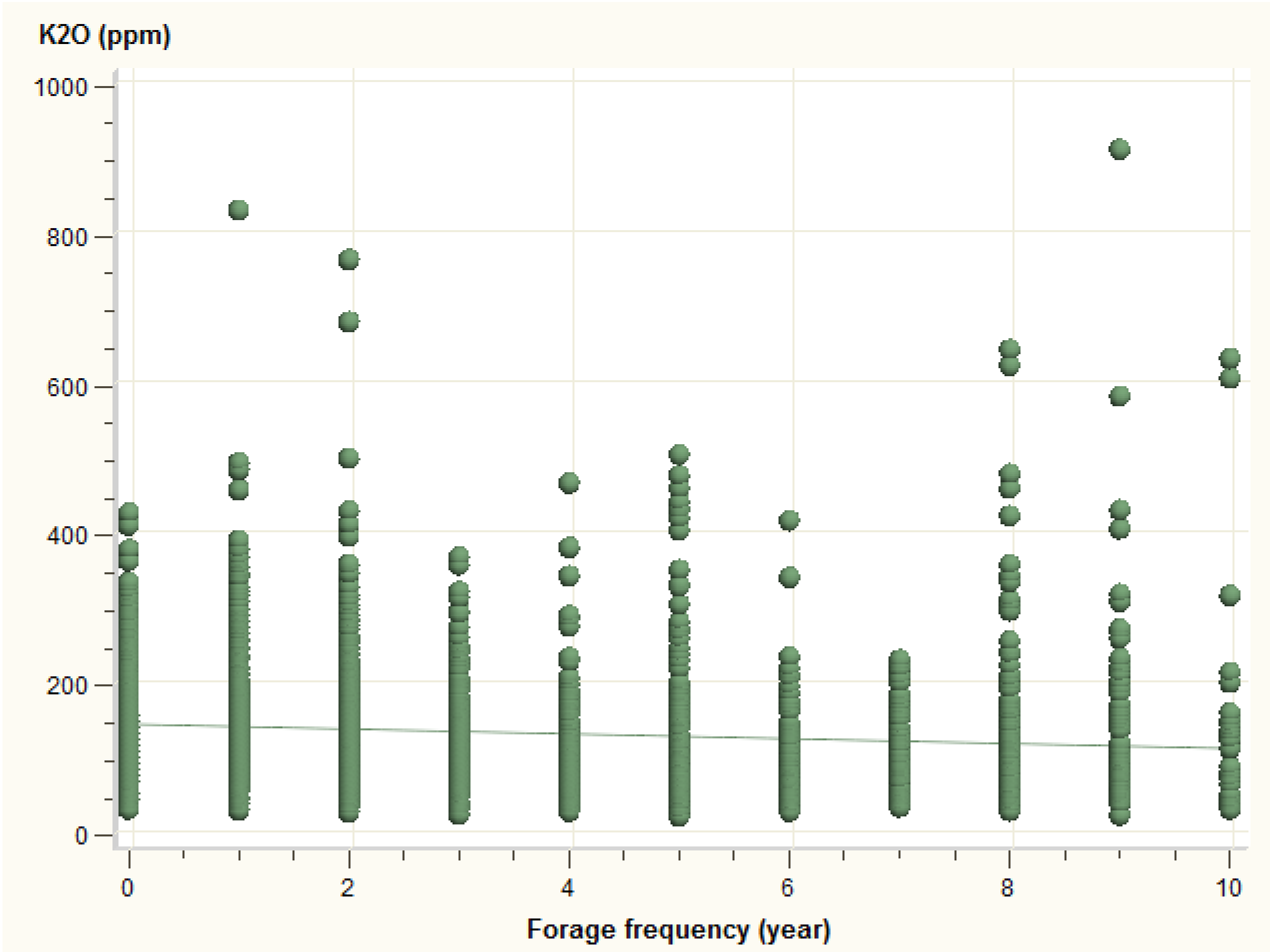


**Figure 19. Potassium  trend versus forage frequency at sampled sites**

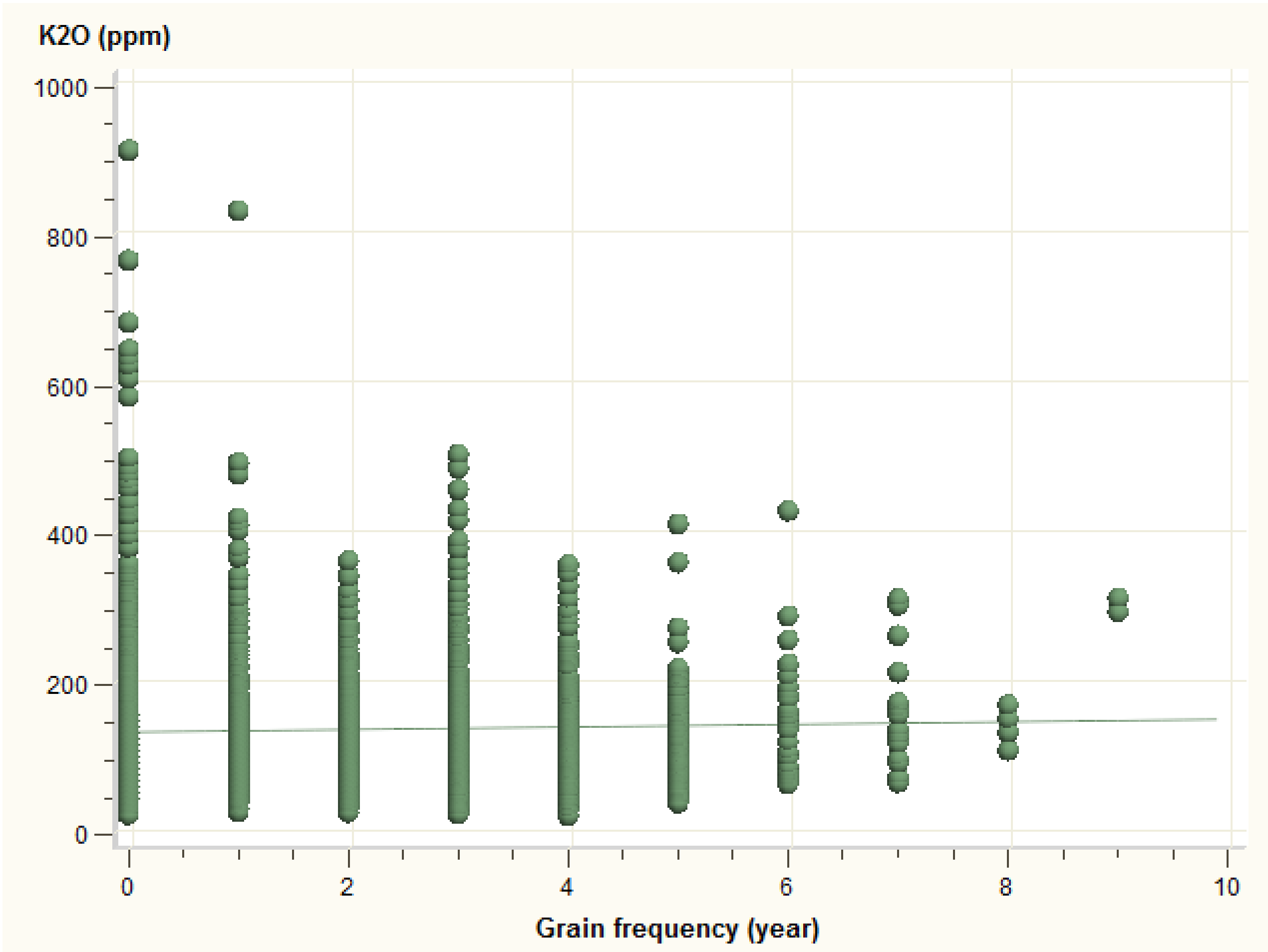


**Figure 20. Potassium trend versus grain frequency at sampled sites**

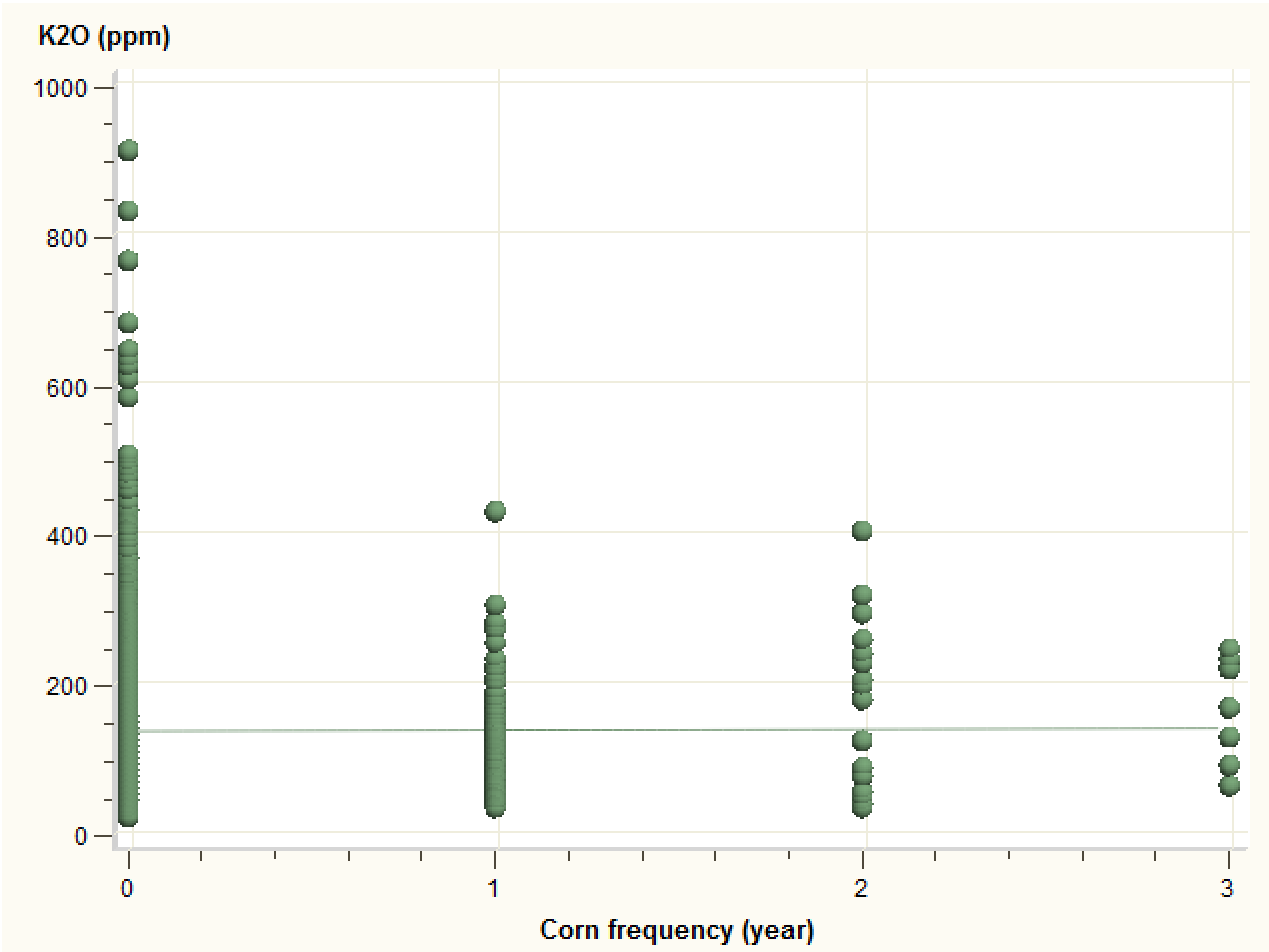


**Figure 21. Potassium trend versus corn frequency at sampled sites**

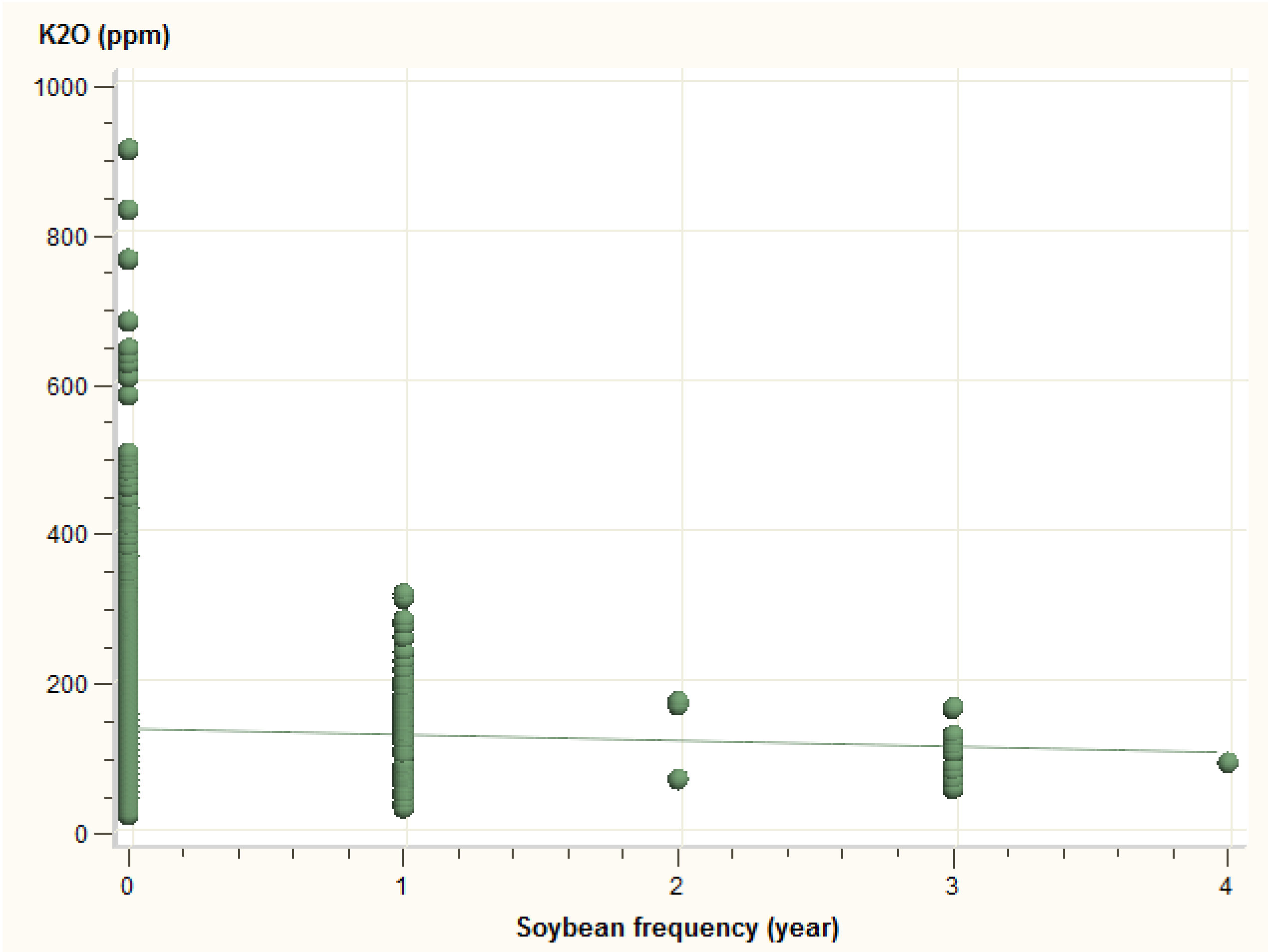


**Figure 22. Potassium  trend versus soybean frequency at sampled sites**

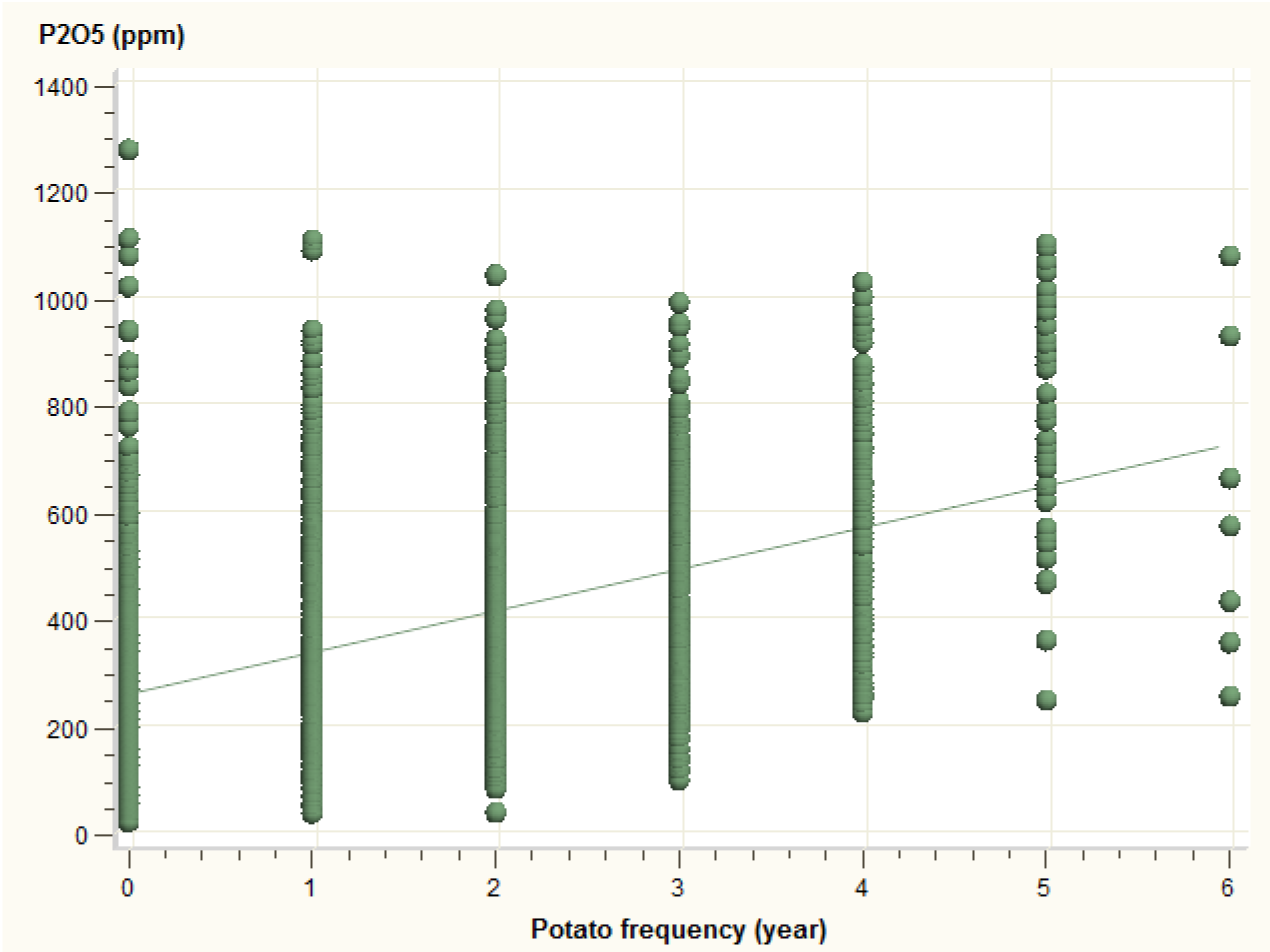


**Figure 23. Phosphate trend versus potato frequency at sampled sites**

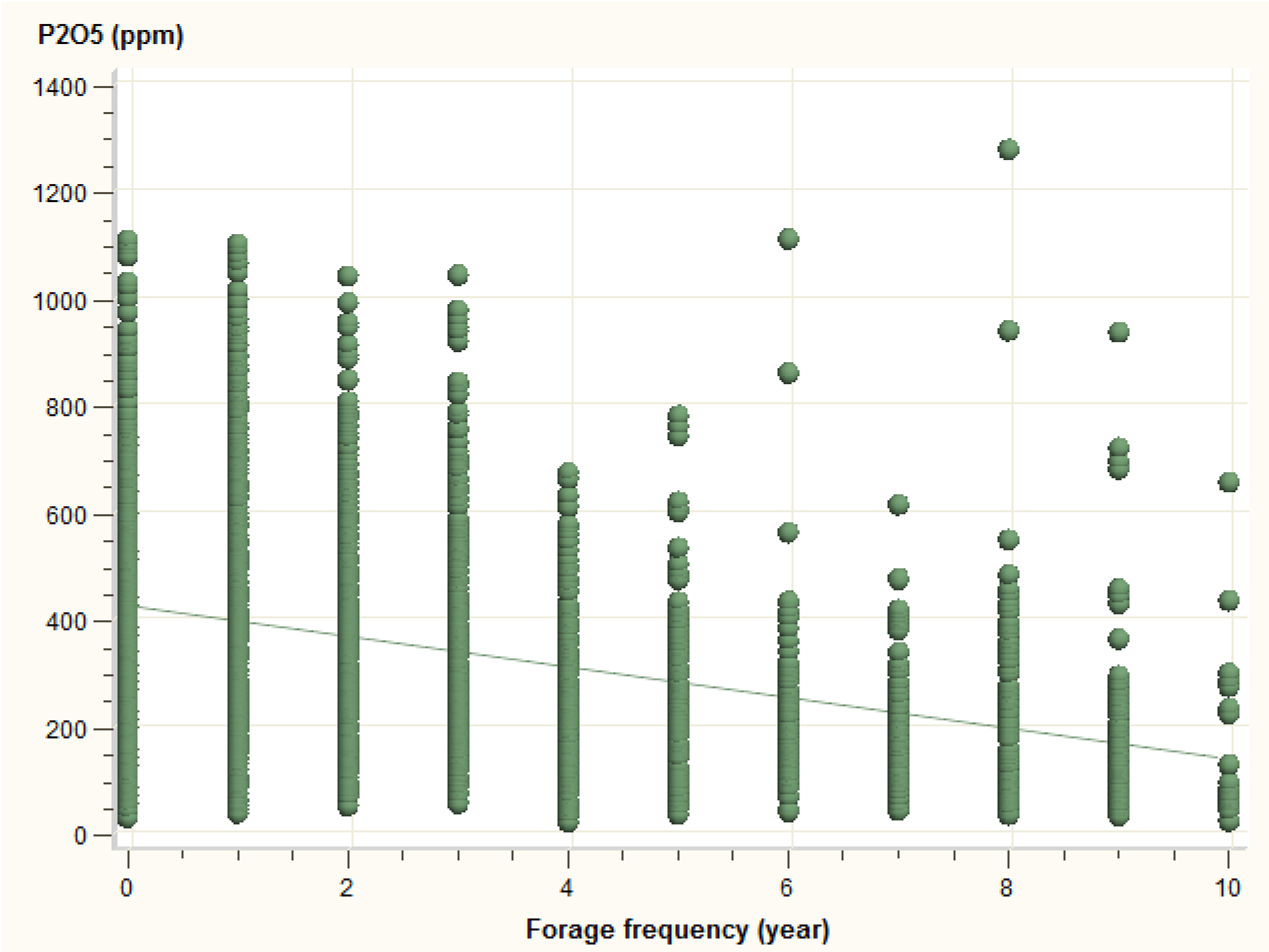


**Figure 24. Phosphate trend versus forage frequency at sampled sites**

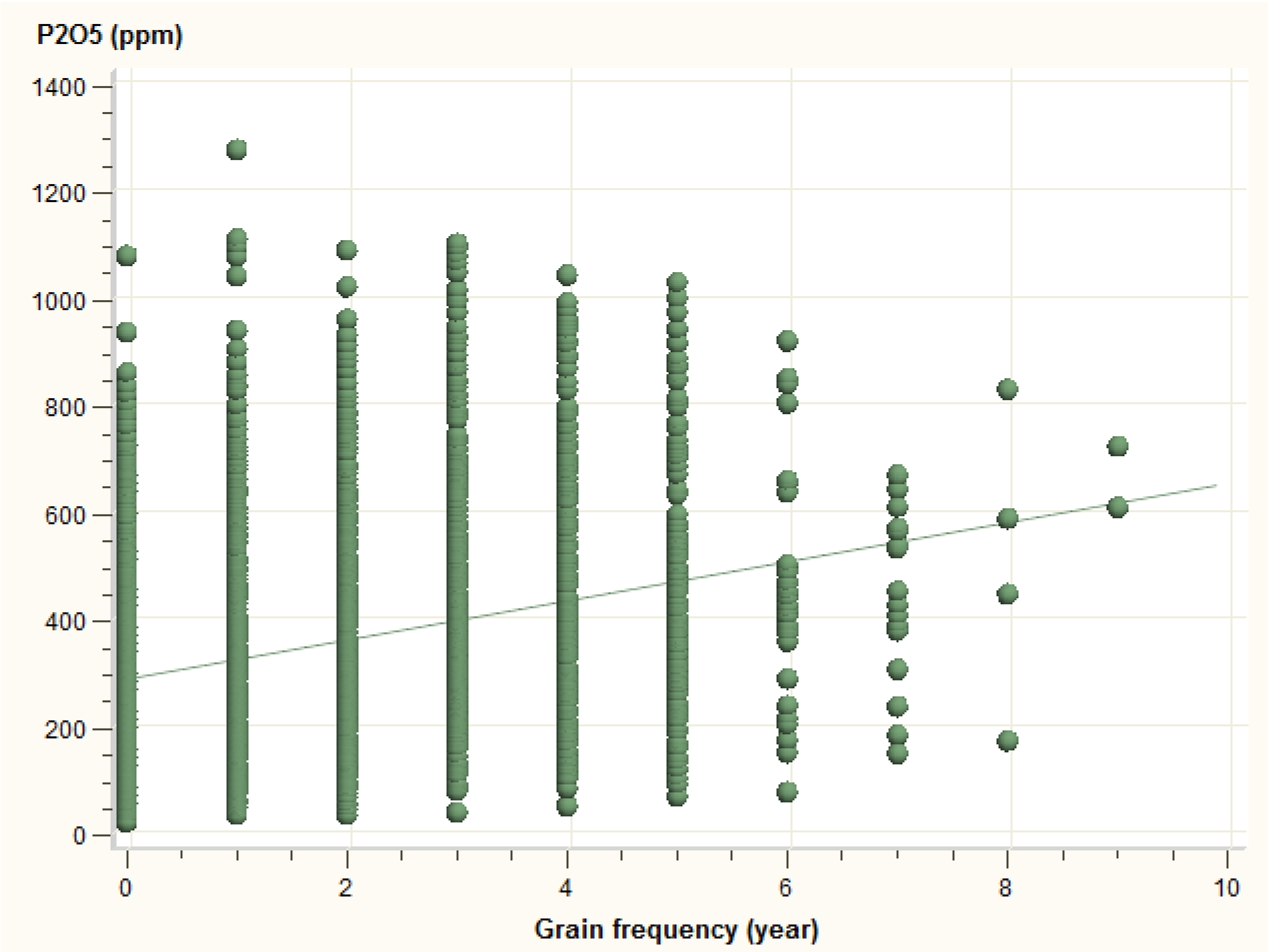


**Figure 25.Phosphate trend versus grain frequency at sampled sites**

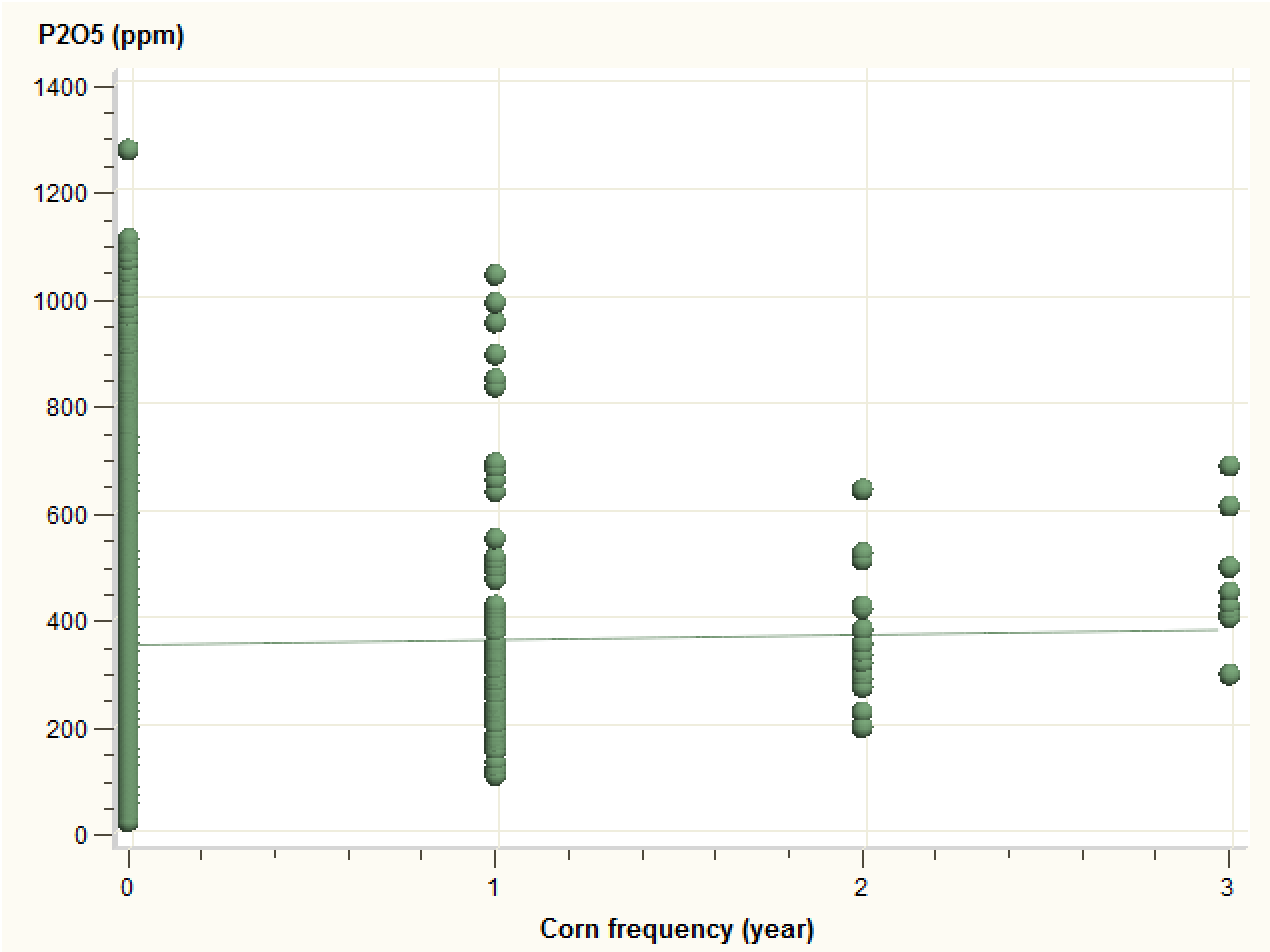


**Figure 26. Phosphate trend versus corn frequency at sampled sites**

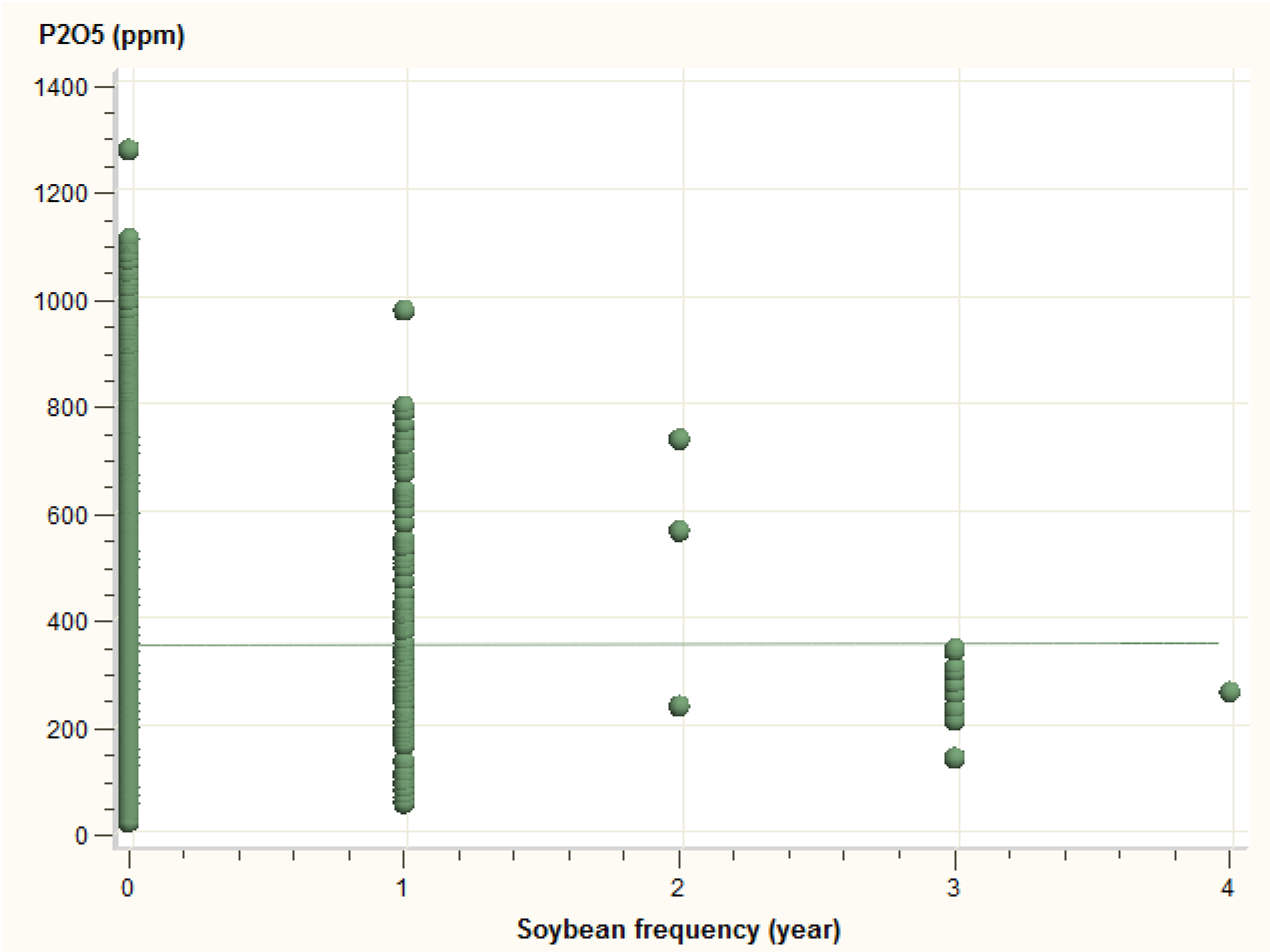


**Figure 27. Phosphate trend versus soybean frequency at sampled sites**

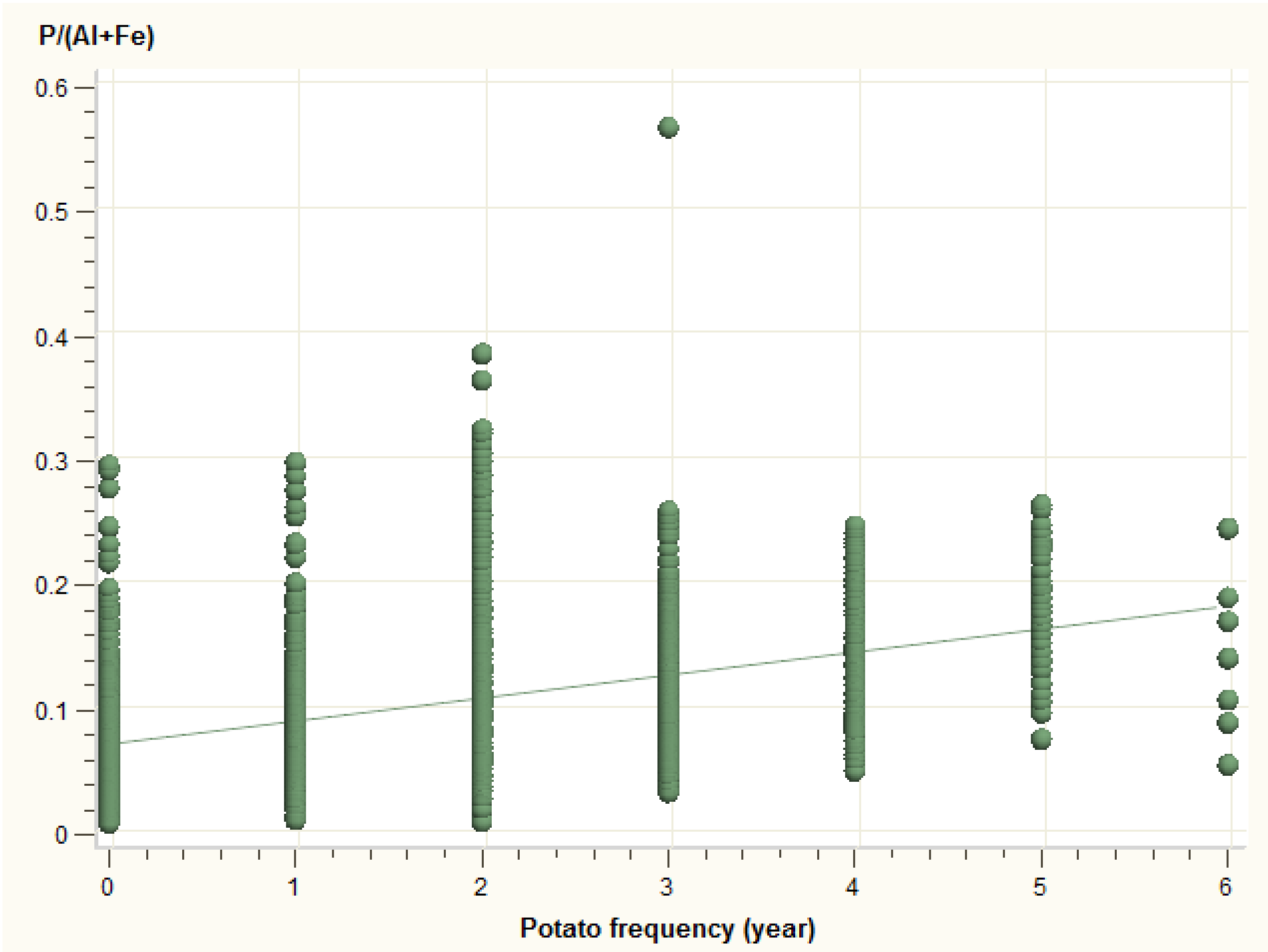


**Figure 28. Phosphate trend versus potato frequency at sampled sites**

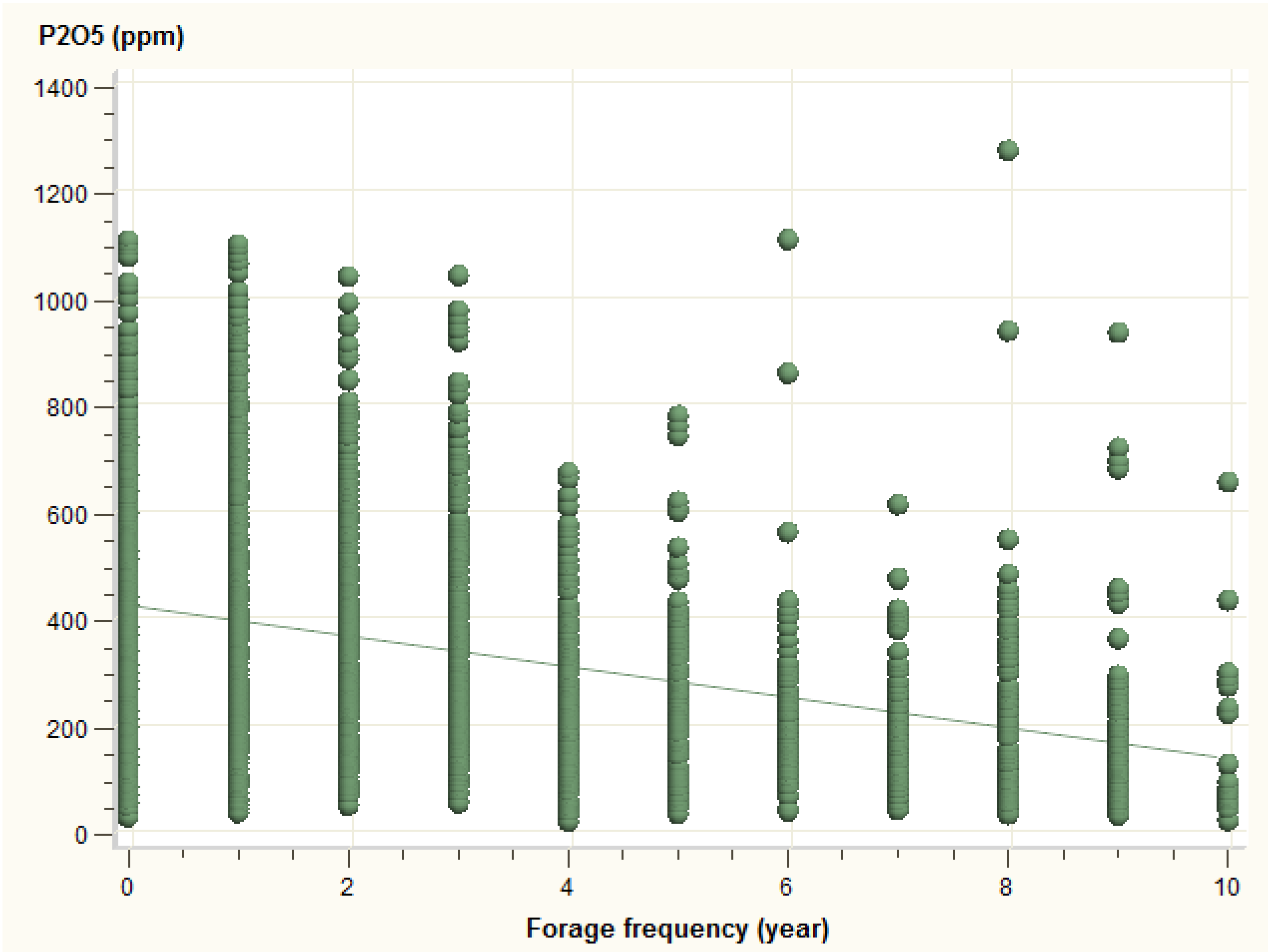


**Figure 29. Phosphate trend versus forage frequency at sampled sites**

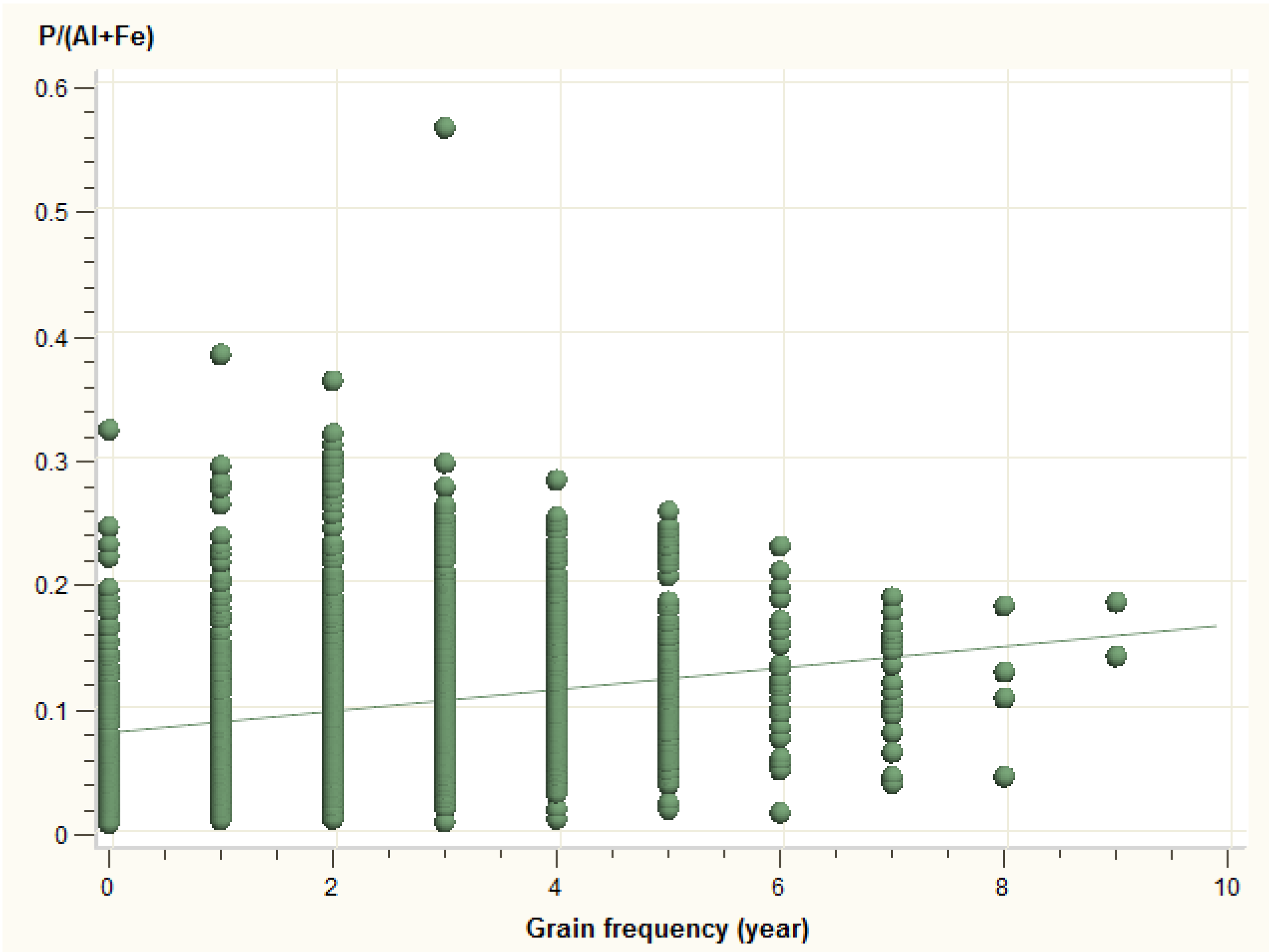


**Figure 30. Phosphate trend versus grain frequency at sampled sites**

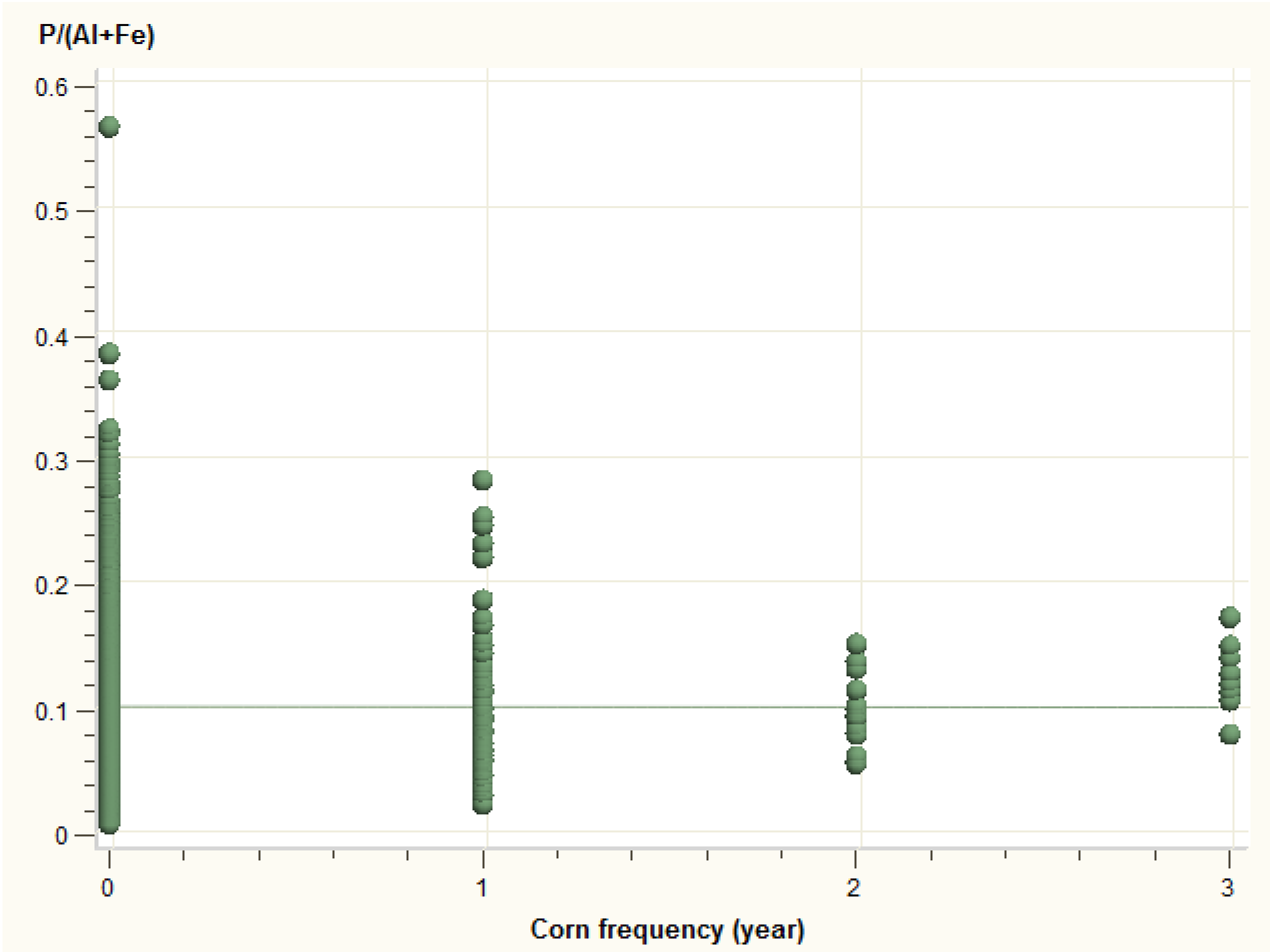


**Figure 31. Phosphate trend versus corn frequency at sampled sites**

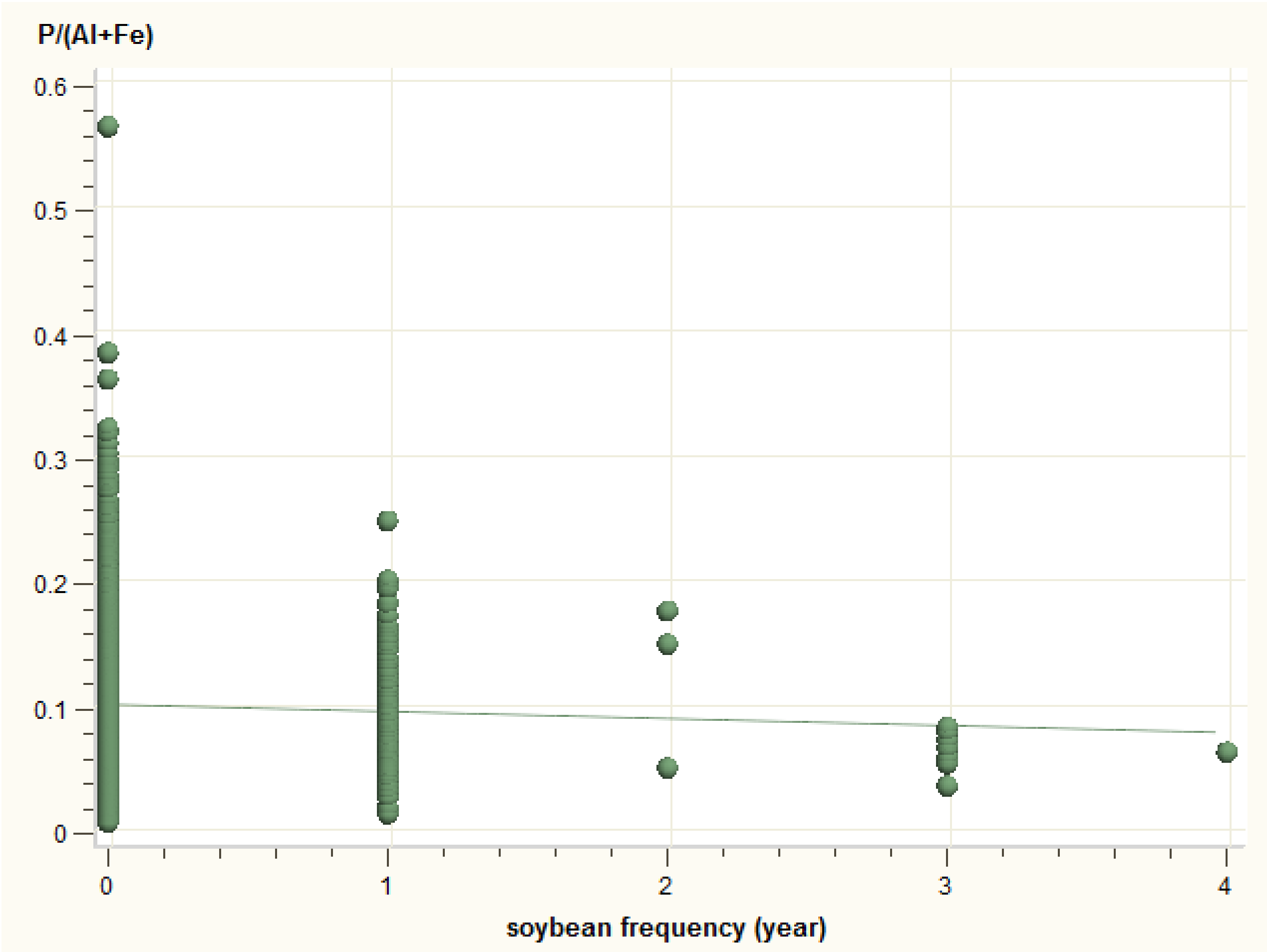


**Figure 32. Phosphate trend versus soybean frequency at sampled sites**

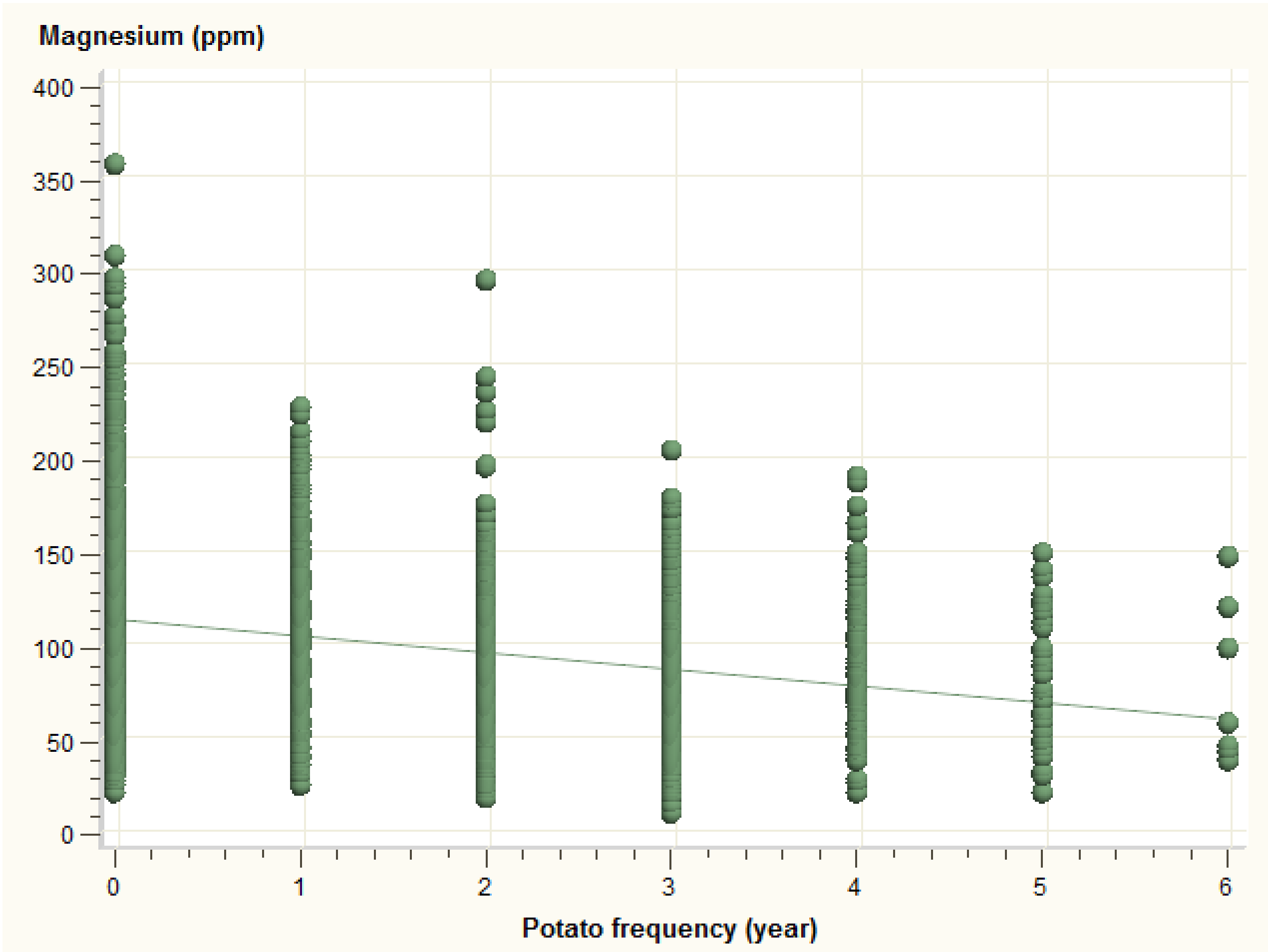


**Figure 33. Magnesium trend versus potato frequency at sampled sites**

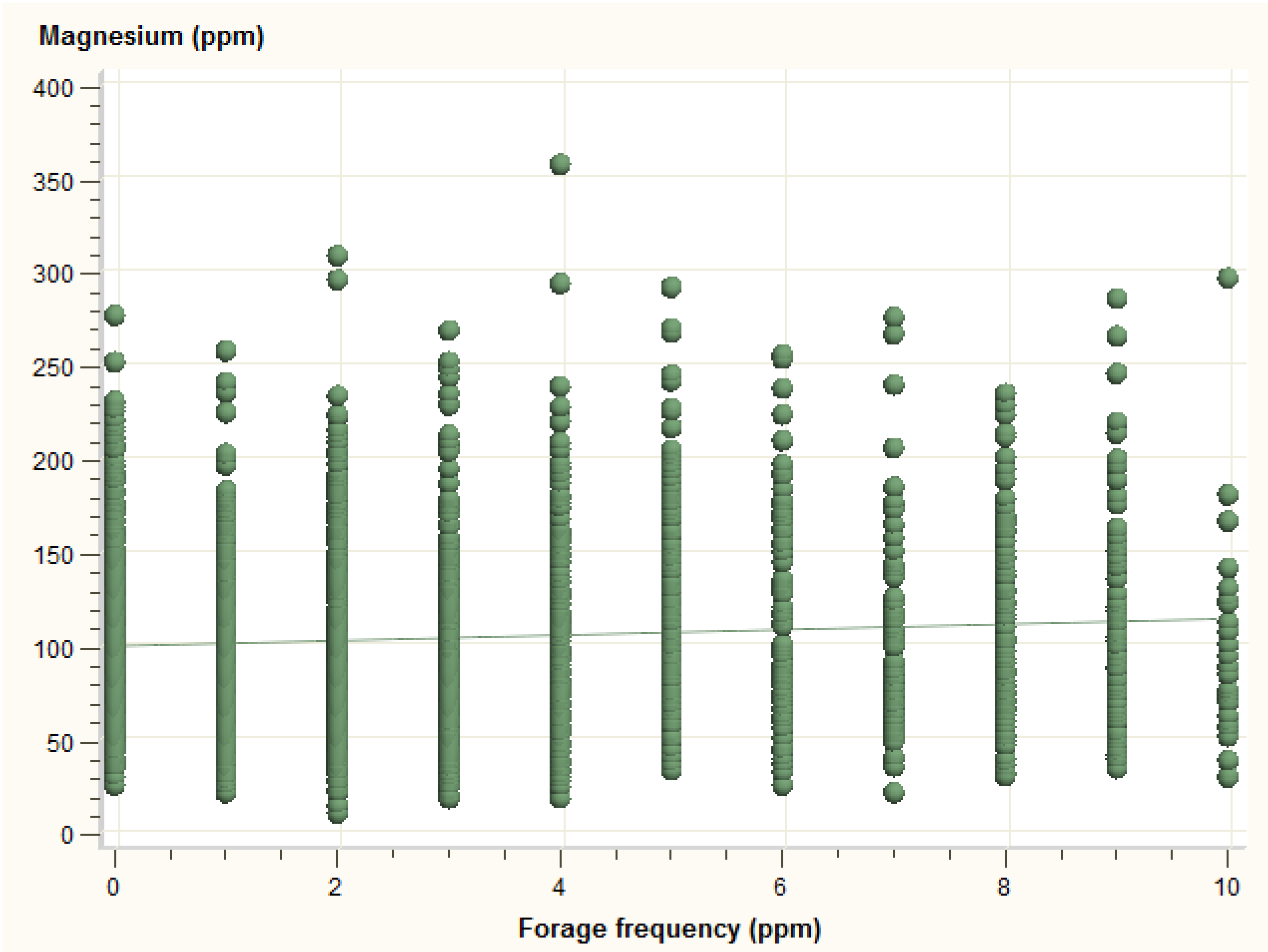


**Figure 34. Magnesium trend versus forage frequency at sampled sites**

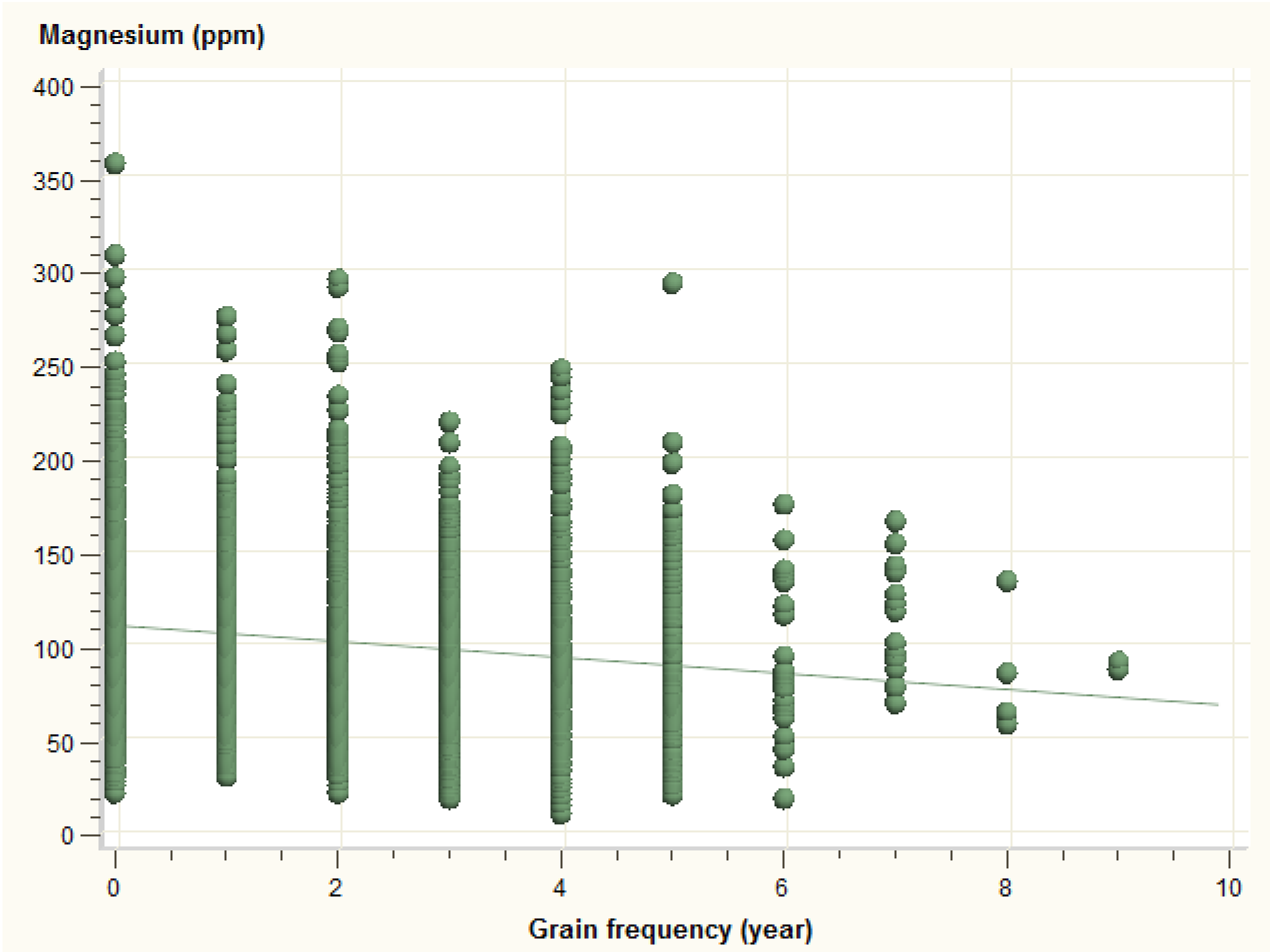


**Figure 35. Magnesium trend versus grain frequency at sampled sites**

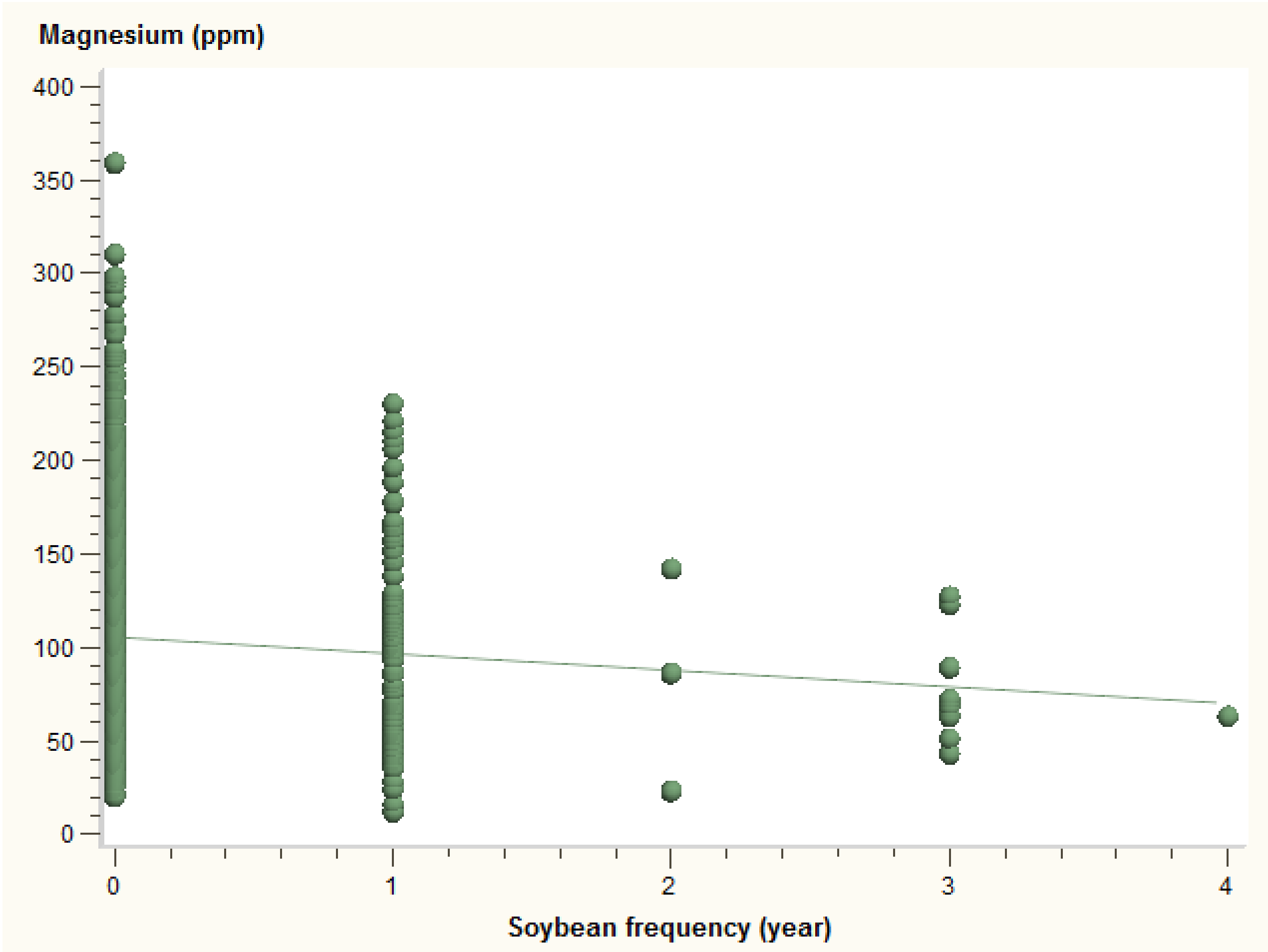


**Figure 36. Magnesium trend versus soybean frequency at sampled sites**

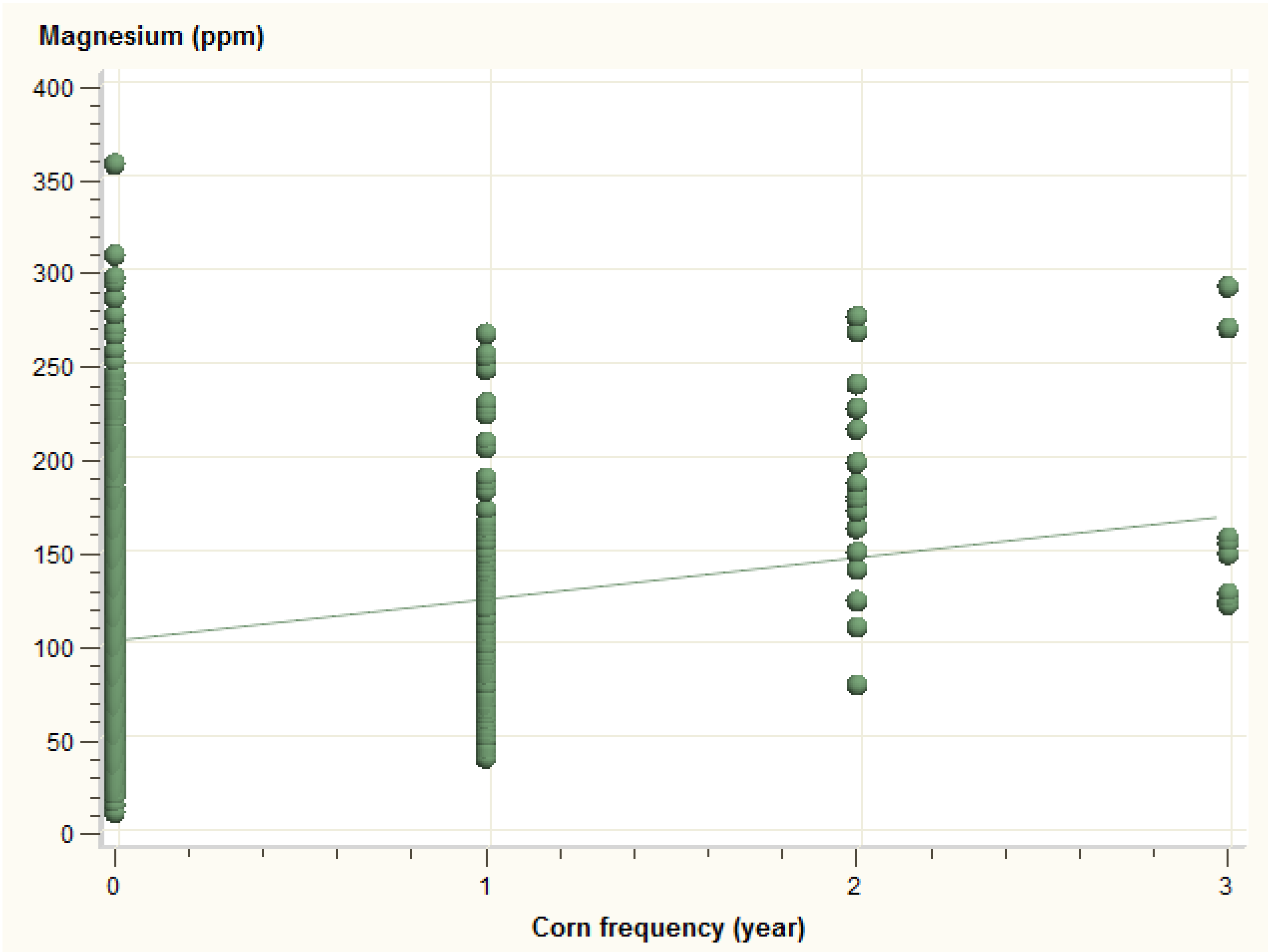


**Figure 37. Magnesium trend versus corn frequency at sampled sites**

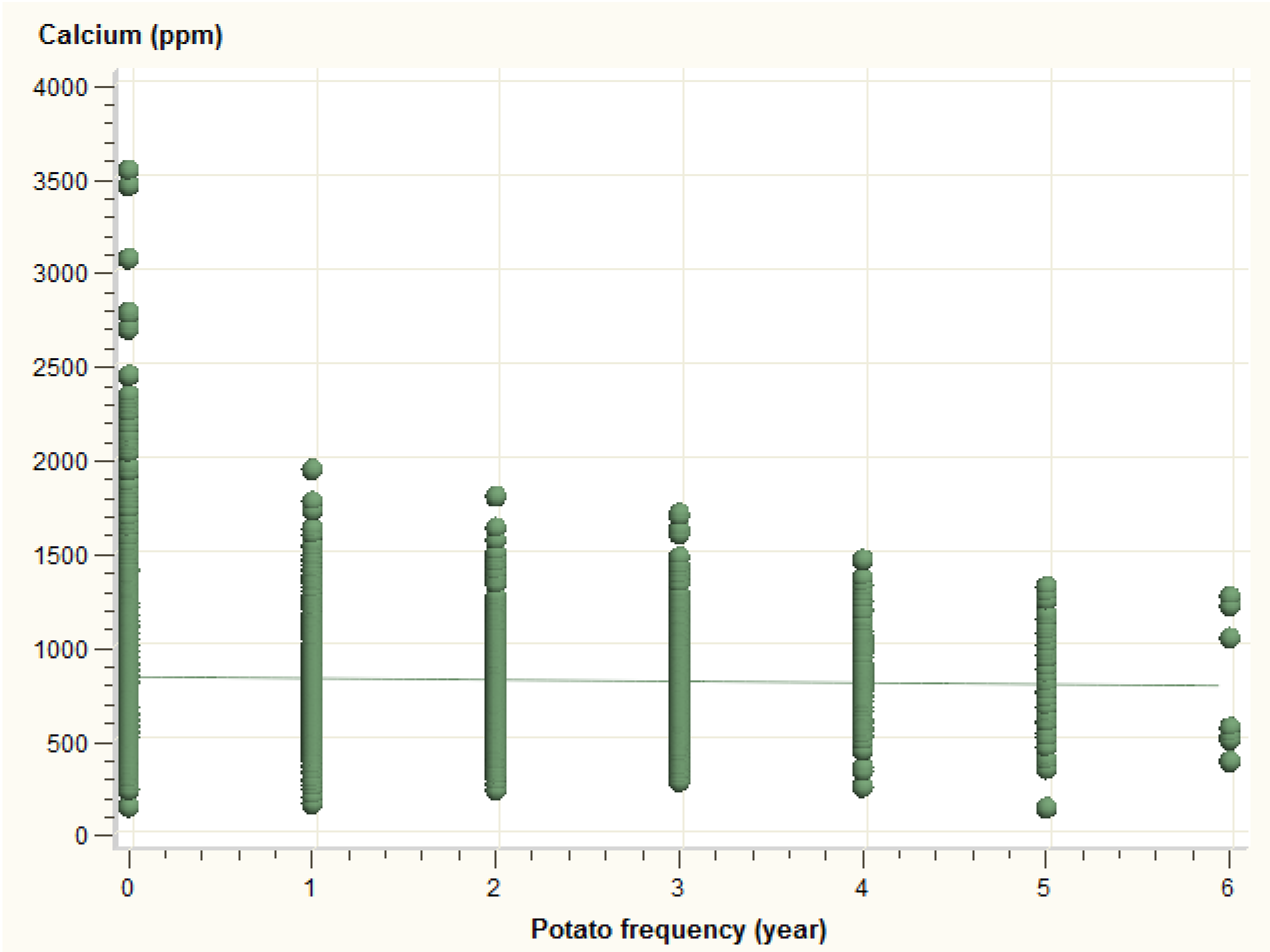


**Figure 38. Calcium trend versus potato frequency at sampled sites**

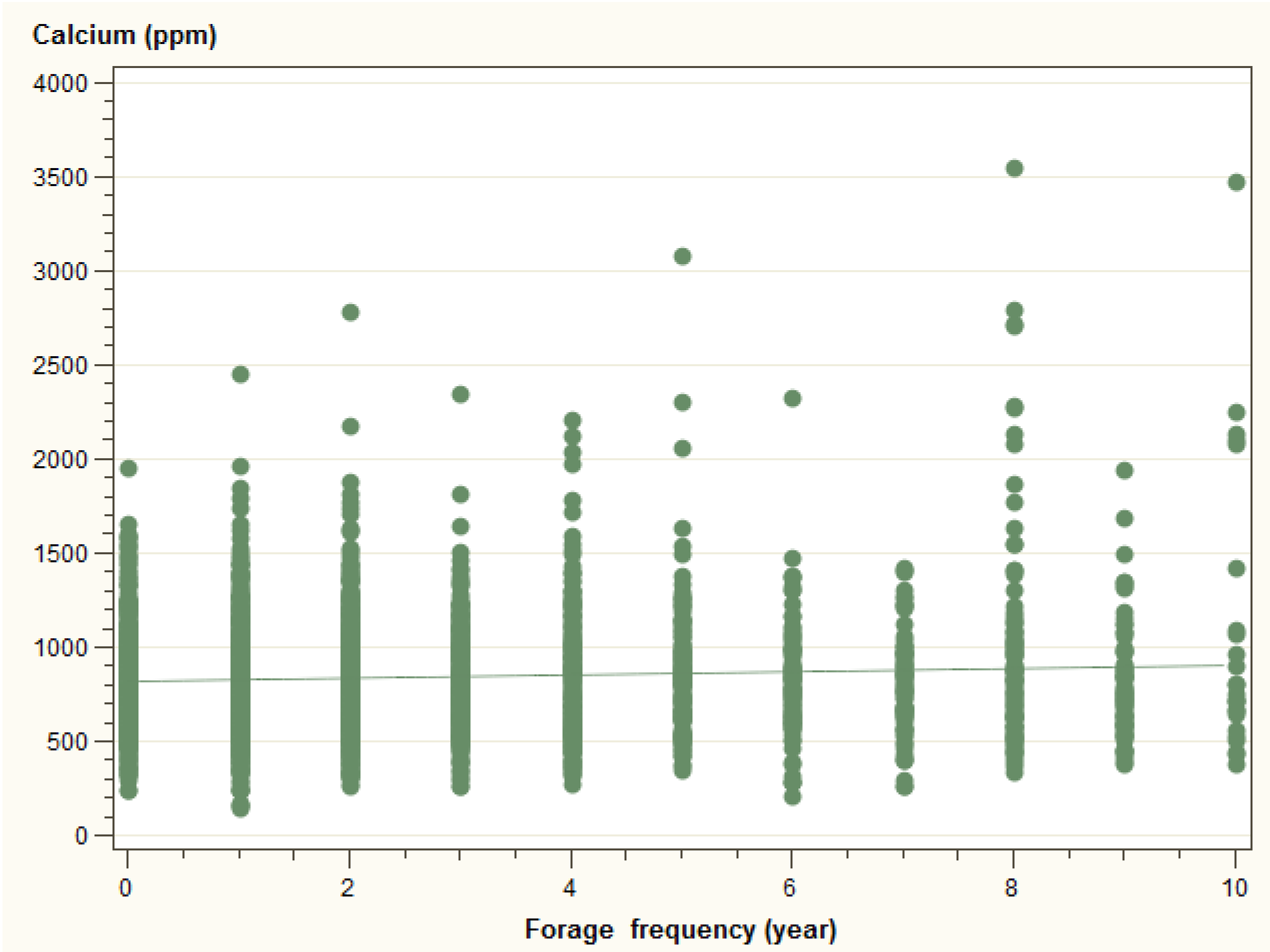


**Figure 39. Calcium trend versus forage frequency at sampled sites**

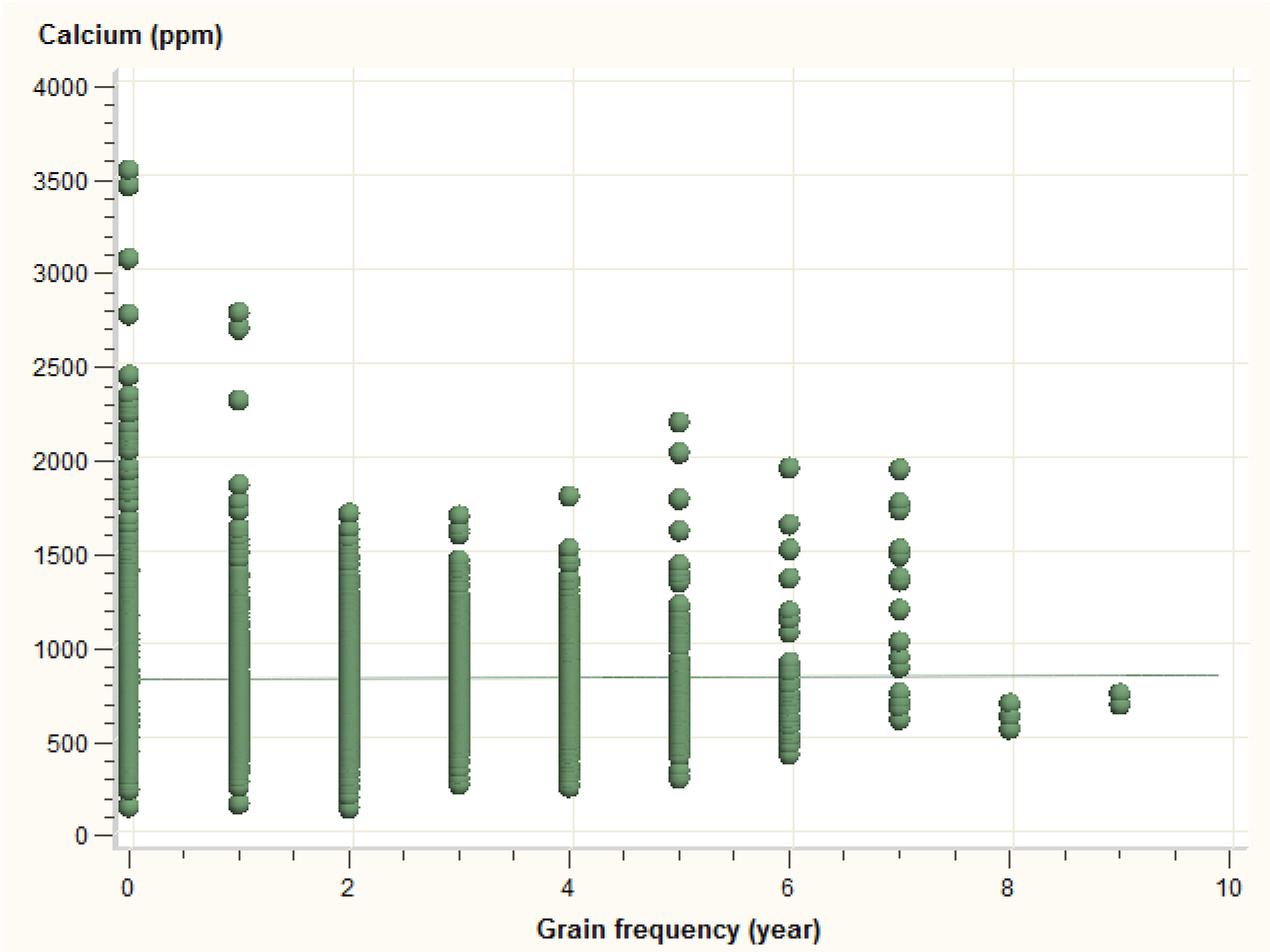


**Figure 40. Calcium trend versus grain frequency at sampled sites**

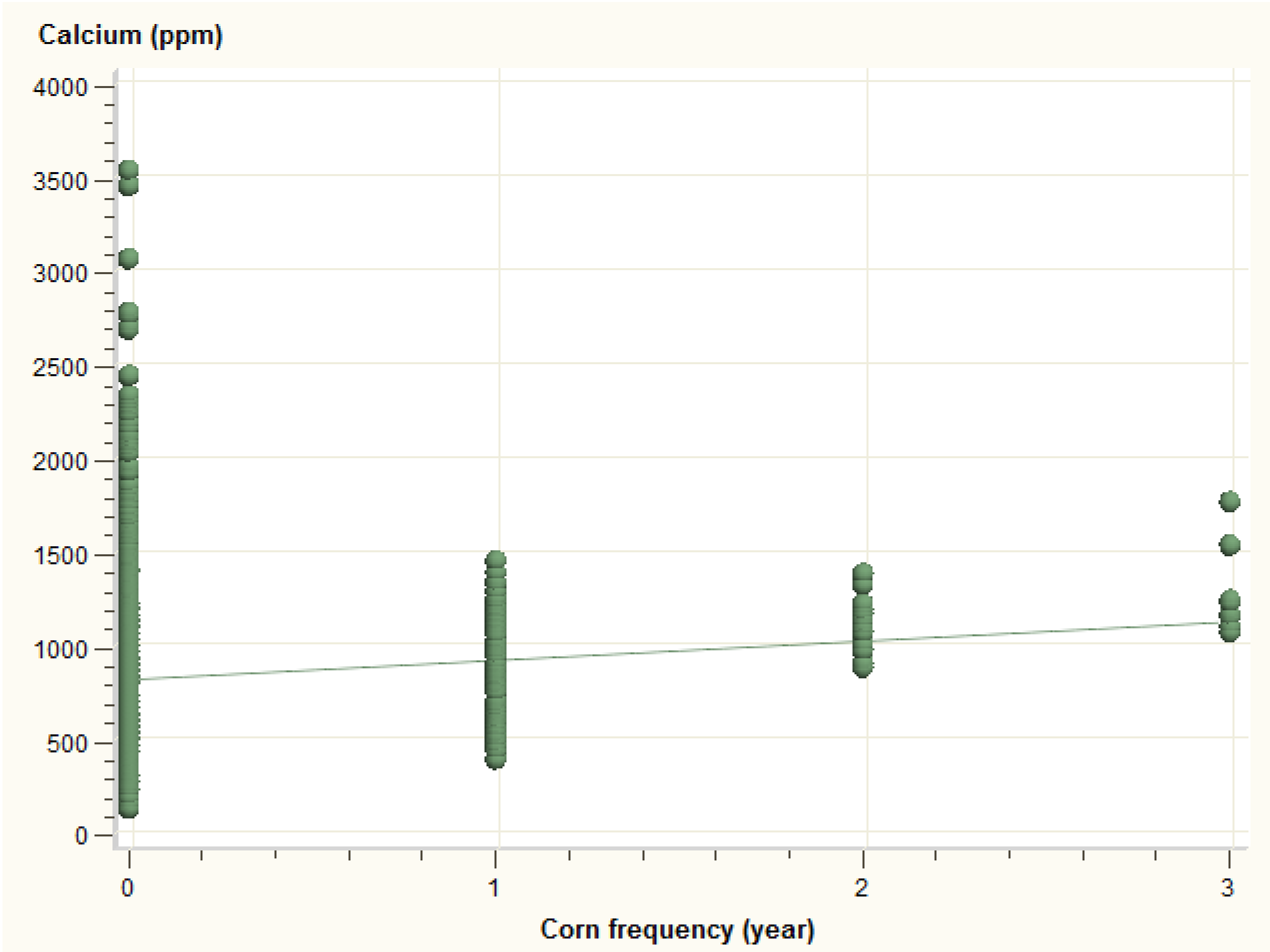


**Figure 41. Calcium trend versus corn frequency at sampled sites**

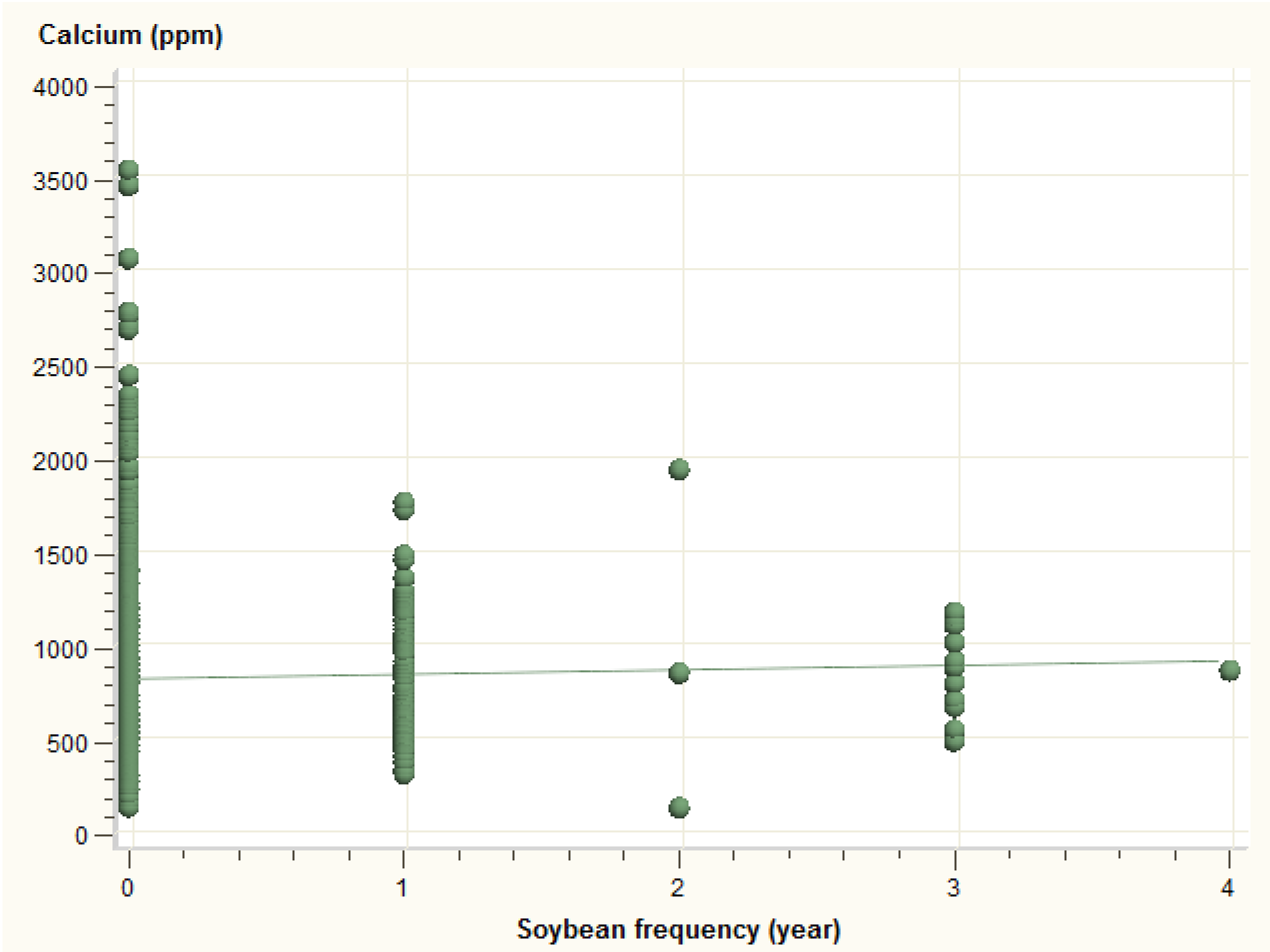


**Figure 42. Calcium trend versus soybean frequency at sampled sites**

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